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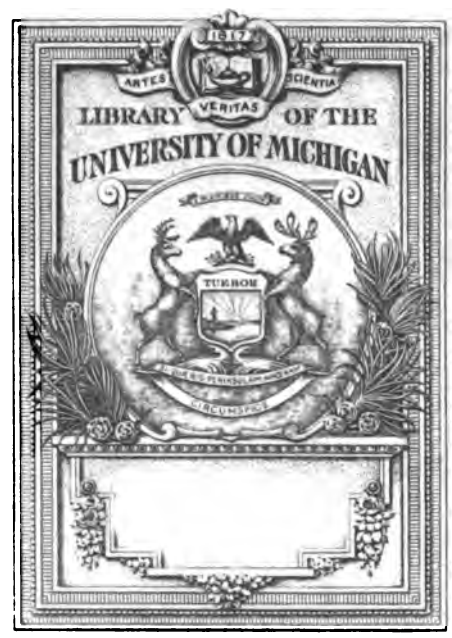
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FOR THE

ADVANCEMENT OF SCIENCE.

I.

SALEM, MASS.
F. W. PUTNAM, PERMANENT SECRETARY, A. A. A. S.
1875.

PRINTED AT THE SALEM PRESS, SALEM, MASS.

LETTER OF GIFT.

PORTLAND, Aug. 22, 1873.

MRS. ELIZABETH THOMPSON of New York City, to-day elected a member, sympathizing with the purposes of our Association in the advancement of science, and seeing the new crop of young and industrious scientific investigators who are to form the future basis of this Association following in the footsteps of the veterans of science who founded it, and being aware of the financial difficulties which often beset the path of those noble men of science who labor more for truth than for profit's sake, wishes to place at the disposal of the Permanent Secretary the sum of one thousand dollars, to be used according to the directions of the Standing Committee, for the promotion and publication of such original investigations by members of the Association as may be accepted by the said Standing Committee, to be published by means of this special donation.

[Signed] P. H. VAN DER WEYDE.

To the Standing Committee of the American
Association for the Advancement of Science.

REPORT

OF THE SPECIAL COMMITTEE ON THE THOMPSON FUND, HARTFORD MEETING, AUGUST, 1874.

THE Standing Committee of the Association at the Portland Meeting appointed the undersigned a Committee with full power to accept and print such papers as they might deem of sufficient importance to be published by the donation of Mrs. Thompson.

In accordance with the duties assigned to them, the Committee have accepted the Memoir by Mr. Scudder on Fossil Butterflies as the first paper to be published by the THOMPSON FUND, and while regretting that the unavoidable delay in engraving the plates prevents their having the gratification of presenting the work at the present Meeting, they believe that the Association and its liberal patron will accept the Memoir as one in every way worthy of the honor thus bestowed.

ASA GRAY,
JAMES HALL,
THOMAS HILL,
P. H. VAN DER WEYDE,
J. L. LECONTE,
T. STERRY HUNT,
F. W. PUTNAM,

Committee.

FOSSIL BUTTERFLIES.

BY

SAMUEL H. SCUDDER.

TO

COUNT GASTON DE SAPORTA,

OF AIX IN PROVENCE,

WHOSE EXTENDED MEMOIRS ON THE FLORA OF THE TERTIARIES OF SOUTHERN FRANCE FORM THE BASIS OF THE BIOLOGICAL CONCLUSIONS OF THIS ESSAY; AND WHOSE UNWONTED COURTESIES HAVE PERMITTED A CAREFUL EXAMINATION OF THE MOST IMPORTANT FOSSIL BUTTERFLIES,

THIS MEMOIR IS RESPECTFULLY INSCRIBED BY

THE AUTHOR.

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INTRODUCTORY.

THE happy discovery in the Museum of Marseilles of a new fossil butterfly first drew my special attention to this group of extinct insects, and determined me to make, during my residence in Europe, a careful study of the original types of all that had been previously described. By the great courtesy of Count Saporta, Professor Heer, Dr. Reynès, Mr. Oustalet, Mr. Woodward, the Rev. Mr. Brodie, Mr. Charlesworth, and the authorities of the Jermyn street Museum, I was able to study not only all the originals of the Museums of Aix, Marseilles, Zurich, Paris, London, Cambridge and Warwick, but several new types, described here for the first time. As I was unable to visit Vienna, Mr. Brunner de Wattenwyl was good enough to procure for me new drawings, made under his immediate supervision, of the species from Radoboj, described by Heer and preserved in the museums of that city. So that I have either personally inspected all the fossils described within recent times as butterflies, or have procured new and excellent original drawings of them, with the exception of Heer's *Vanessa attavina* (*Sphinx atava* Charp.), which I was unable to find, and two fragments of slight value, viz.: the hind wing referred by Heer to his *Vanessa Pluto*, and the portion of a hind wing, called *Cyllonium Hewitsonianum* by Westwood. In the hope of drawing attention to fossil butterflies, which have been hitherto so little studied, I have brought together in this connection all that has been published of this group of fossils, whether of text or illustration; presenting thus, within a small compass, a complete account of our knowledge of these insects, as a basis for future investigations.

BIBLIOGRAPHY.

1726. Hueber. Lithographiæ Wirceburgensis specimen primum. Fol. Wirceburg. This work contains the first reference to fossil Lepidoptera which I have found. In his Synopsis Tabellarum, he gives on page 94:

"Tabulâ XV. Similium insectorum alatorum Papilionum videlicet diversas species;" but the plates are too rude to be of the slightest value or even to indicate the suborder to which the insects may belong.

1729. Bromell. Lithographia Suecana. Acta Litteraria Sueciæ, II. In a section *de lapidibus insectiferis Seanicis et Gothicis* (p. 525) he says:

"Praeter umbratiles etenim papilionum vel muscarum quasdam imagines, lapidi huic leviter sed distincte impressas, multa scarabæorum figuras, mole totaque facie imitantur;" these were found in "saxo fœtido" in "Westrogothia."

In his enumeration of fossils he specifies further:

[528]. "9. Papilionum majorum ac minorum imagines et impressiones nitidæ, in lapide calcario communi inodoro, ubi etiam in alio fœtido conspicuæ, ex eisdem Westrogothiæ locis."

[529]. "10. Insectorum ovula, an nymphæ seu aureliæ lapideæ? saxo fœtido nigricanti immersæ. Ex eadem parœcia karabylonga."

[531]. "14. Papilionum minorum imagines et impressiones, in ejusdem generis saxo suillo fœtido. Ex eodem loco. Hæ itidem figura sua a papilionibus illis differre haud videntur, quarum superius Num. 9. meminimus."

I find no later reference to these supposed Lepidoptera.

1742. Sendelius. Historia succinorum. Fol. Lipsiæ.

Devotes a chapter (*De Erucis*, pp. 169–171) to supposed remains of caterpillars and chrysalides in amber. Several forms are figured (pl. 5, figs. 25–28; pl. 6, figs. 1–4), of which it is not impossible that pl. 6, fig. 1, may represent a Papilionid larva; and pl. 6, fig. 4, the chrysalis of a Nymphalid; but the illustrations are wholly insufficient to assert anything of them with confidence.

1828. Marcel de Serres. Note sur les Arachnides et les Insectes fossiles et spécialement sur ceux des terrains d'eau douce. Ann. Sc. Nat., XV, 98–108.

This is an extract only from the next citation.

1829. MARCEL DE SERRES. Géognosie des terrains tertiaires ou Tableau des principaux animaux invertébrês des terrains marins tertiaires du midi de la France. 16mo. Montpellier et Paris.

Contains a "Tableau des Arachnides et des Insectes fossiles du bassin tertiaire d'Aix (Bouches-du-Rhône)," printed in the preceding citation, in which (p. 230; p. 107 of preceding) occurs the genus "Papilio," with the remark: "Nous citons ici, sous la foi d'autrui, un Lépidoptère diurne de la division des *Satyrus*," doubtless referring to *Neorinopis sepulta*.

Speaking of the authors who have treated of the fossils of Œningen, he says: (p. 235) "Ces divers naturalistes y ont signalé des Scarabées, des Lucanus (p. 236) fort rapprochés du Lucanus cervus, des Papillons," etc.

In a "Tableau général des Arachnides et des Insectes fossiles" he gives on p. 257, the following:

Noms des genres.	Genres qui se trouvent dans les terrains anormaux.					
	Tertiaires.			Secondaires.		
	postérieurs à la retraite des mers.	antérieurs à la retraite des mers dans les couches de		supérieurs jurassiques.	inférieurs.	Nombre d'espèces.
		marnes calcaires.	lignite et succin.			
Papilio.		*	*		*	4

In the "marnes calcaires" of Aix he has referred already, as we have seen, to one; he previously speaks of *Papillons* at Œningen (see above) and may therefore place two in the second column; he quotes Sendelius as probably figuring caterpillars in amber as follows (p. 242): "Des Lépidoptères (M. Brongniart). On a cru reconnaître des chenilles parmi les insectes du Succin figurés par Sendelius Tab. 3, fig. 28–82;"[1] and this accounts for one in his third column; and the following passage from the section on "Insectes fossiles des terrains secondaires inférieurs, ou de transitions" (p. 246) accounts for that in the fifth column: "Il se peut que ce soit également dans des formations de la même époque qu'existent les vestiges d'insectes, d'ailes de Papillons et de Scarabées signalés par Bromel."

1835. GRAVENHORST. Bericht der entomologischen Section. Uebers. d. Arbeit u. Veränd. Schlesisch. Gesellsch. Vaterl. Cultur, 1854, 92–93.

Gives a general enumeration of the collection of fossils from amber in the museum of the Königsberg Society, specifying a few Lepidoptera.

[1] Probably an error for Tab. 5, fig. 28a, 28b, which seems to represent a Tenthredinidous larva.

1836. HOPE. Observations on Succinic Insects. Trans. Ent. Soc. Lond., I, iii, 133–147.

In a list of insects observed in amber we find the following on p. 146:

GENUS.	AUTHOR.	SUBSTANCE.	COLLECTION.
"Papilio.	Hope and Berendt.	Animé and amber.	Mr. Strong."

1838. BRONN. Lethæa Geognostica, 2d ed., II. 8vo.

In a tabular list of fossil insects, with localities, he gives (p. 814):

Papilis [Papilio] (Bernstein), Satyrus (Gyps formation von Aix).

1838. DUPONCHEL. Ann. Soc. Ent. France, VII, Bull. 51–52.

Re-announces the discovery of *Neorinopis sepulta*, referring it to Nymphalis.

1839. BOISDUVAL. Ann. Soc. Ent. France, VIII, Bull., 11–12.

Gives a verbal report on the characteristics of *Neorinopis sepulta*, drawn from an inspection of a drawing sent by Fonscolombe to Audouin, refers the insect to the genus Cyllo and says that the species is allied to Europa and others.

1840. BOISDUVAL. Rapport sur une empreinte de Lépidoptère trouvée dans les marnes des environs d'Aix, en Provence, et communiquée par M. de Saporta. Ann. Soc. Ent. France, IX, 371–374. Accompanied by a plate (viii) which appeared in the second livrasion.

Describes *Neorinopis sepulta* from the specimen, referring it to the genus Cyllo, and the neighborhood of the species Rohria, Caumas and Europa, and giving it the specific name sepulta.

1843. MARCEL DE SERRES. Notes géologiques sur la Provence. Actes Linn. Soc. Bord., XIII, 1–82; Note additionelle, 83–90; Deuxième note additionelle, 170–2. 2 planches.

In a list of the plants and animals found at Aix, the author gives on p. 41: "Lépidoptères Diurnes. Papilio de la division des Satyrus. Cette espèce conserve encore en partie ses couleurs." On p. 172 is a *Note relative au Lépidoptère figuré* (*Cyllo sepulta*), in which Boisduval's opinion of its relationship is given.[1] The author's review of the plants and animals leads him to the generalization that they are analogous to those which now live in dry and arid spots in the south of France.

1843. CHARPENTIER. Ueber einige fossile Insecten aus Radoboj in Croatien. Acta Acad. Leop. Carol., XX, 401–410.

Describes (p. 408) and figures (Tab. xxii, fig. 4) *Eugonia atava* under the name of *Sphinx atavus*.

1845. COQUAND. Bull. Soc. Geol. France [2], II, 384–386.

Refers to and quotes a portion of Boisduval's description of *Neorinopis sepulta*; nothing new is added.

[1] The plate, however, is wanting, both in the copy belonging to the Smithsonian Institution and in that in the Library of the Boston Society of Natural History, so that I cannot tell whether it is copied from Boisduval's figure or is an original.

1845. Marcel de Serres. Sur les fossiles du bassin d'Aix (Bouches-du-Rhône). Ann. Sc. Nat. [3], IV, 249–256.

Uses the discovery of *Neorinopis sepulta* as an argument in support of his theory that there is an intimate relation between the tertiary fauna and flora of Aix and the animals and plants now existing in southern France; and that the climate of the two epochs was the same. Recalling the then recent discovery of many butterflies new to the fauna of Europe, he suggests that *N. sepulta* may yet be found alive.

1847. Hope. Observations on the fossil insects of Aix in Provence, with descriptions and figures of three species. Trans. Ent. Soc. Lond., IV, 250–255.

Gives a list of genera published by Bronn with some additions; on p. 252, under Lepidoptera, we have "85. Satyrus B[ronn]."

1849. Heer. Die Insektenfauna der Tertiärgebilde von Œningen und von Radoboj in Croatien. 2er Theil. 4to. Leipzig. Extracted from the Neue Denkschr. allg. Schweiz. Gesellschaft für Naturw., XI (1850).

Contains (pp. 177–183, Taf. xiv, figs. 3–6) descriptions and illustrations of *Eugonia atava* (*Vanessa attavina*), *Mylothrites Pluto* (*Vanessa Pluto*) and *Pontia Freyeri* (*Pierites Freyeri*).

1849. Heer. Zur Geschichte der Insekten. Verhandl. Schweiz. naturf. Gesellsch., XXXIV, 78–97.

Refers to the late epoch at which Lepidoptera appeared, and adds, pp. 87–8: "Merkwürdig ist, dass von diesen Schmetterlingen 2 Arten grosse Aehnlichkeit [88] mit ostindischen Arten haben, während eine mit unserm Distelfalter, eine andere mit unserem Grassackträger zu vergleichen ist."

1850. Heer. Zur Geschichte der Insekten. Neues Jahrb. für Mineral., 17–33.
On the History of Insects. Quart. Journ. Geol. Soc. Lond., VI, ii, 68–76. Translated by T. R[ymer] J[ones].

Essentially the same as the preceding. The quotation given above is found on p. 24 of the Jahrbuch, p. 72 of the Journal. "Schmetterlinge" is everywhere translated Butterflies instead of Lepidoptera. Aix in Provence is nearly always given as Aix-la-Chapelle.

1851. Lefebvre. Observations relatives à l'empreinte d'un Lépidoptère fossile (*Cyllo sepulta*) du docteur Boisduval. Ann. Soc. Ent. France [2], IX, 71–88, pl. 3, No. II.

Criticises at length the opinion of Dr. Boisduval on the systematic position and structure of *Neorinopis sepulta*, maintaining that the fore and not the hind wing was furnished with a tail, and while confessing his inability to decide upon its relationship, inclines to the opinion that the insect was more nearly allied to Vanessa. His studies were wholly taken from the plate published by Boisduval.

1851. Boisduval. Quelques mots de réponse à M. Alex. Lefebvre sur ses observations relatives à la *Cyllo sepulta*. Ann. Soc. Ent. France [2], IX, Bull. 96–98.

Defends his views against the criticisms of Lefebvre.

1852. GIEBEL. Deutschland's Petrefacten. p. 644. 8vo. Leipzig.

Catalogues the three butterflies described by Heer from Radoboj.

1854. WESTWOOD. Contributions to Fossil Entomology. Quart. Journ. Geol. Soc. Lond., X, 378–96, pl. 14–18.

Represents on pl. 17, fig. 17, and pl. 18, fig. 27, two fragments of wings, which he considers as belonging to butterflies, and to which, on pp. 395–6, in the explanation of the plates, he gives the names of *Cyllonium Boisduvalianum* and *C. Hewitsonianum*.

1854. PICTET. Traite de Palæontologie, II, pp. 392–393, pl. 40. 8vo. Paris.

Gives a brief account of the fossil butterflies then known, and reproduces excellently the figures of *Neorinopis sepulta*, and *Mylothrites Pluto* given by Boisduval and Heer.

1856. GIEBEL. Fauna der Vorwelt, II. pp. 185–7. 8vo. Leipzig.

Gives a similar but fuller account of the butterflies described by Heer and a brief notice of others.

1856. GIEBEL. Geologische Uebersicht der vorweltlichen Insekten. Zeitschr. gesammt. Naturw., VIII, pp. 174–188.

Gives lists of Lepidoptera summarized from his previous work.

1856. HEER. Ueber die fossilen Insekten von Aix in der Provence. Vierteljahrsschr. naturf. Gesellsch. Zurich, I, 1–40.

Simply mentions in his introductory remarks the occurrence of *Neorinopis sepulta* at Aix, and says that most of the insects from this locality present a Mediterranean aspect.

1858. HEER. Ueber die Insectfauna von Radoboj. Bericht 32ª Versamml. Deutsch. Naturf., 118–121.

A cursory review of Radoboj insects, mentioning the rarity of Lepidoptera, and specifying *Eugonia atava* (*Vanessa attavina*) and *Mylothrites Pluto* (*Vanessa Pluto*). He remarks that the former resembles *V. cardui* and probably fed on thistles, although these had not yet been found in a fossil condition in that locality; and that the latter was nearly allied to *Papilio Hadena*.

1859. HEYDEN. Fossile Insecten aus der Rheinischen Braunkohle. Dunk. u. Mey. Palæontogr., VIII, 1–15, Taf. 1–2.

Contains pp. 12–13, Taf. I, fig. 10, description and figure of *Thanatites vetula* (*Vanessa vetula*).

1860. HEER. Untersuchungen über das Klima und die Vegetations Verhältnisse des Tertiärlandes. 4to. Winterthur.

Refers to some of the fossil butterflies described from Radoboj and Aix.

1861. HEER. Recherches sur le climat et la Végétation du pays tertiaires; traduction de Gaudin. 4to. Winterthur.

The same as the previous; and also (on p. 205; not in the original edition) the following reference: "un cinquième (*Thaites Ruminiana*) est tres voisin du genre Thais qui appartient à la faune méditerranéene."

1868. BUTLER. Catalogue of Diurnal Lepidoptera of the family Satyridæ in the collection of the British Museum. 8vo. London.

Gives an appendix (pp. 189–190) on fossil species, in which he discusses the zoological position of *Neorinopis sepulta* (*Cyllo sepulta*).

1869. BUTLER. Catalogue of Diurnal Lepidoptera described by Fabricius in the collection of the British Museum. 8vo. London.

Discusses briefly (p. 109) the relationship of "*Vanessa Pluto*" to *Argynnis Diana* and *Junonia Hedonia*.

1872. SCUDDER. Description d'un nouveau papillon fossile (*Satyrites Reynesii*) trouvé à Aix en Provence. Rev. et Mag. de Zool., 62–71, pl. 7. Also separate, pp. 7.

Description of a New Fossil Butterfly (*Satyrites Reynesii*) found at Aix in Provence. This is a translation of a portion of my paper. Geol. Mag., IX, 532–533, pl. 13, figs. 2–3. The same, separate, pp. 2.

Describes and figures *Lethites Reynesii*.

1872. SAPORTA. Études sur la végétation du Sud Est de la France à l'epoque tertiaire. Suppl. I. Révision de la flore des gypses d'Aix. 1er fascicule, Généralites. Ann. Sc. Nat. [5], Bot. XV, 277–351.

Discusses (p. 342) the probable food of the caterpillars of *Neorinopis sepulta* and *Thaites Ruminiana*.

1873. BUTLER. On Fossil Butterflies. Lepidoptera Exotica, part xv, pp. 126–8, pl. 48.

On a Fossil Butterfly belonging to the family Nymphalidæ from the Stonesfield slate near Oxford; with notices of two other foreign forms from France and Croatia. Geol. Mag., X, No. ciii, 2–4, pl. 1.

Describes the genus Palæontina and species oolitica (a supposed fossil butterfly), refers *Cyllo sepulta* Boisd. to a new genus, Neorinopis, and *Vanessa Pluto* Heer, doubtfully, to Junonia, adding remarks upon the relationships of each.

1873. ANON. The oldest Fossil Butterfly in the World. The [London] Graphic. Feb. 22.

A popular account of the preceding paper, accompanied by a woodcut of *Palæontina oolitica*.

1873. Brodie. The Distribution and Correlation of Fossil Insects, etc. 8vo. pamph. Warwick.

Gives a brief notice (pp. 8–9) of the various fossils referred to butterflies, especially of *Palæontina oolitica* and *Lethites Reynesii*, and publishes an opinion expressed to him by me that the former was Homopterous.

1874. Scudder. Proc. Bost. Soc. Nat. Hist., XVI, 112.

Doubts the lepidopterous character of Butler's Palæontina, and refers it, probably, to the Cicadinæ.

1874. Butler. Notes on the impression of *Palæontina oolitica* in the Jermyn Street Museum. Geol. Mag. [2], I, 446–449, pl. 19.

Defends the lepidopterous character of Palæontina and gives new illustrations of the same.

1874. Smith. Discovery of Remains of Plants and Insects. Nature, XI, 88.

Enumerates fossils found at Gurnet Bay, and specifies among them "butterflies."

Sehn wir daher durch das Fenster,
In das alte Schattenreich,
Sehen wir da statt Gespenster,
Wesen, die den jetz'gen gleich;
Sehen nicht des Pluto Schrecken,
Sphinxe und Harpyen Brut,
Nicht Chimären Flammen lecken,
In der Hölle Feuer Glut,

Nein! in diesen stillen Räumen
Wo man sich den Orcus denkt,
Sehn wir tausend Wesen träumen,
Tief in ew'gen Schlaf versenkt.
Haben einst die welt genossen,
Unterm blauen Himmelszelt,
Jetzt sind sie in Fels verschlossen,
In der schwarzen Unterwelt.

OSWALD HEER.

DESCRIPTIVE.

NYMPHALES—PRÆTORES—OREADES.

Genus NEORINOPIS Butler.

Neorinopis Butler, Lepid. Exot., i, 127 (1873);—Ib., Geol. Mag. x, 8.

In the shape of the wings (Pl. I, fig. 8) this genus closely resembles Neorina (Pl. II, fig. 13). The fore wings are arched and roundly produced at the apex, though not so strongly as in Neorina, rather as in Antirrhæa or Cœlites, the costal margin is regularly, but not, as in Neorina, very strongly arched, and the apex is well rounded; the outer border is sinuous and scarcely crenulate, the upper portion, above the middle of the subcosto-median interspace, very strongly convex and particularly prominent at the tip of the second inferior subcostal nervule; below, the margin is again convex, starting from the middle of the upper median interspace; at first (over one interspace) gently, afterward more fully, but still rather broadly, to the well rounded lower angle; the inner margin is slightly concave. The hind wings resemble those of Neorina far more than those of any other genus, but are long and proportionally rather more produced than in Neorina, with less crenation of the outer border, and a shorter and slenderer tail; the costal margin is strongly and abruptly convex next the base, but beyond this passes with a regular and gentle convexity to the outer angle, which is larger than a right angle and somewhat rounded off; above the tail the general trend of the outer border forms scarcely more than a right angle with the general course of the costal margin and is gently crenate; the tail, which lengthens the upper median nervule by about one-fourth, is about the width of an interspace at the base and tapers to a rounded point, at first rapidly, afterward slightly; the

border is slightly angulated at the tip of the middle median nervule, and still more strongly at the tip of the lowest median nervule, causing in the latter a very broad angular projection, beyond which the margin slopes off and is rounded at the angle. The inner margin has a very broad and extensive basal projection, and the course of the internal nervure renders it probable that it was even more extensive than represented in the plate; it reaches more than half-way along the inner border, and at the broadest exceeds the cell in width; beyond it the inner margin has a nearly straight course, parallel and adjacent to the sub-median nervure.

As to the neuration (Pl. I, fig. 9) this genus approaches more closely the genera Zophoessa (Pl. II, fig. 1), Neorina (Pl. II, fig. 8), Debis (Pl. II, fig. 10), and Lethe (Pl. II, fig. 6), than any others, although it differs from any of them more than they do among themselves. The most noticeable marks of distinction are these: in the fossil genus the first superior subcostal nervule of the fore wing is thrown off just at the extremity of the cell while the second and third are far beyond it; in the recent genera the first nervule is always emitted some distance before the tip of the cell and the second either at or before the extremity; in agreement with this, the cell is much shorter in Neorinopis than in the others, being but two-fifths the length of the wing, while in the others it is about one-half its length; in Neorinopis the nervule closing the cell of the fore wing unites with the median nervure at its last divarication, while in the others it strikes it a long distance beyond. In the hind wing the vein closing the cell strikes the median at its last divarication, as in Zophoessa, while in the others it meets the last branch of that vein at a slight distance from its origin.

In the fore wings the costal nervure terminates at a little distance beyond the middle of the costal border. The subcostal terminates, as in the recent genera mentioned, near the tip of the wing, and has four superior and two inferior branches; the four superior nervules and the costal nervure terminate at nearly equal distances apart on the costal border; the first superior nervule is emitted from the very tip of the upper border of the cell, at two-fifths the distance

from the base to the apex of the wing, the second beyond the cell, but scarcely beyond the middle of the wing; the third at a less distance from the base of the second than that is from the first, and directly below a point midway between the tip of the costal nervure and that of the first superior subcostal nervule; the fourth near the extremity of the wing and but little before the tip of the third superior nervule, or at about two-thirds the distance from the base of the third superior subcostal nervule to the tip of the subcostal nervure; the first inferior subcostal nervule originates of course at the tip of the cell, and separates but narrowly from the main stem, from which it diverges very gradually as far as the base of the outer superior nervule, where the main stem approaches it again; the lowermost inferior subcostal nervule arises from the first inferior scarcely beyond its base, curves inward, downward and then outward before taking a course parallel to the nervule above, from which it is separated at its base by twice the distance that the former is there distant from the subcostal nervure; the vein closing the cell can scarcely be called a vein, but rather a break in the membrane such as is often seen in recent butterflies, and is indicated in the fossil by a curving granulated streak; it arises from the final curve of the lowermost inferior subcostal nervule opposite and directly below its origin; it passes thence in a slightly curved line, opening outward, to the very base of the upper branch of the median nervure. The median nervure runs in a straight line as far as its first divarication, which is a little beyond the middle of the cell; thence it is bent parallel to the subcostal nervure and exactly at the lower tip of the cell forks, the branches parting but gradually from each other, the upper gently curved, the lower nearly straight. The submedian nervure is parallel to the lowest median nervule, as in Neorina, etc. None of the veins are swollen at the base. The cell is three and a half times longer than broad.

In the hind wing the neuration is almost precisely that of *Neorina Lowii* (Pl. II, fig. 8). The costal and subcostal veins are confluent for a short distance, when the costal parts from its neighbor at nearly right angles and immediately thereafter sends up the basal shoot, which, after passing in a straight line half

way toward the basal angle of the costal margin, curves slightly outward and fades away; the costal nervure, on approaching the border, curves outward and meets the border near the middle of its outer two-thirds; the subcostal breaks into three branches, exactly as in Zophoessa. The median nervure and its middle branch form a continuous, almost exactly straight line, from which the lowermost branch parts opposite the union of the vein closing the cell with the lowest subcostal nervule; and the uppermost at exactly the tip of the cell, or as far beyond the origin of the lowest nervule as the upper limit of the vein closing the cell is from the base of the upper subcostal nervule; the vein closing the cell is a very weak one and originates on the lowest subcostal nervule, as far from the second divarication of the subcostal nervure as that is from the first, and passes in a gentle curve, opening outward, to the second divarication of the median nervure. The submedian and internal nervures are united for a short distance beyond the base of the cell; the submedian passes with a gentle regular curve to the outer border, at the lower outer angle; the internal parts from this with an opposing curve and terminates somewhere below the middle of the inner flap of the wing, probably approaching again the submedian nervure near its extremity. None of the veins are swollen at the base. The cell is two and three-quarters times longer than broad.

In the disposition of its markings (Pl. I, fig. 8) this genus does not seem to show any strong affinity with any living butterflies, although it has some features in common with the genera already referred to (Pl. II, figs. 3, 9, 11, 13, 14). The base of the wing is dark, followed by paler spots and bands, differing greatly in the front and hind wings, followed again by a belt of dusky scales, which separates from the rest of the wing a paler submarginal band, enclosing roundish, interspaceal, often pupillated spots of varying size, and whose outer limits are at least an interspace's distance from the outer border; the latter is margined, on the hind wings, with alternating darker and lighter lines. The middle portions of the two wings differ; the hind wings have simply a broad pale field, gradually merging on either side into the darker parts and varied by a cloudy, wavy, narrow, transverse belt near the middle; the fore wing, on the other hand, is

marked by two large diagonal light patches, whose interior edges are well defined, but whose exterior are powdered at their confluence with the darker parts; one of these patches crosses the subcostal interspaces at a little distance beyond the cell, and reaches from the subcostal to the median nervure; the other crosses the middle of the outer half of the cell and covers a great part of the basal half of the lower median interspace; while a third roundish patch, united with it, occurs near the middle of the medio-submedian interspace. The two diagonal patches have their inner distinct edges nearly parallel and straight, following lines which run at nearly right angles to the costal margin; in this respect they agree with the diagonal disposition of markings upon the upper and under surface of some species of Zophoessa (Pl. II, figs. 3, 11) and Lethe (Pl. II, fig. 9), while the nature of the broad patches themselves may best be compared to such masses of color as we see in *Neorina Lowii* (Pl. II, fig. 13) and some other species; the marginal markings of the hind wings and the submarginal spots are common to very many Oreades, but the nature and disposition of those of Neorinopis and the disparity of their character on the two wings are best seen on a comparison with the types we have already alluded to, and which are represented on the plates. The small round pale spots accompanying larger dark ones on the fore wing may be seen in *Neorina Lowii*, though the relation of the two is different from what we see in Neorinopis, while the greater importance of the ocellus in the lower median interspace of the hind wings finds an exaggerated counterpart in *Neorina Lowii*. In general, the design of the fore wings approaches that of *Neorina Lowii* more nearly than that of the upper surface of any other butterfly I have seen, although there is a distant resemblance to the markings of Antirrhæa and Anchiphlebia, as Butler has remarked, as well as toward certain species of Zophoessa. The markings of the upper and under surface of butterflies have nearly always some and often a close relation to each other, and therefore we may reasonably look at the under surface of living insects to find the nearest counterpart to our fossil; in this respect the under surface of *Lethe Dyrta* (Pl. II, fig. 9) may well be studied, where in a lighter submarginal band we find a series of spots, in the principal interspaces, far from the border; these are ocellated instead of double as in Neorinopis; there

are two large patches of pale color in the upper half of the wing as in Neorinopis, but the inner is much obscured by a dark bar crossing the middle; and the outer instead of the inner patch is connected with the lighter parts of the lower half of the wing, and is separated from the parts within by a long line whose general course is at right angles to the costal border; in the markings of the hind wings it is by no means unlike *Zophoessa Sura* (Pl. II, fig. 3), and resembles less conspicuously *Debis Sinorix* (Pl. II, fig. 14), with which also it agrees admirably in the form and neuration of the wing; in the shape of the tail particularly, and in the size of the insect also, Neorinopis agrees better with *Debis Sinorix* than with any butterfly I have been able to examine. In neuration and in markings, although not at all in the form of the wings, this fossil shows no distant alliance to our own *Enodia Portlandia.*

The other parts of the body are not sufficiently preserved to admit of their use in generic description, if we except the hind legs; these are slender, the tarsi (which are barely shorter than the thorax) being of the same length as the tibiæ and a very little longer than the femora.

NEORINOPIS SEPULTA (BOISDUVAL) BUTLER.

Plate I, figs. 8-17.

Nymphalis sp. DUP., Bull. Soc. Ent. France, 1838, 51-52.

Cyllo sp. BOISD., Bull. Soc. Ent. France, 1839, 11-12.

Cyllo sepulta BOISD., Ann. Soc. Ent. France, ix, 371-374, pl. viii (1840); IB., Bull. Soc. Ent. France, 1851, 96-98; SERRES, Act. Linn. Soc. Bord., xiii, 172, pl. ii (1843); WESTW., Gen. Diurn. Lep., 361 (1851); LEF., Ann. Soc. Ent. France [2], ix, 71-88, pl. iii, II (1851); PICT., Traite Pal., ii, 393, pl. xl, fig. 11, 1854; BUTL., Cat. Satyr. Brit. Mus., 189-190 (1868).

Antirrhœa? sepulta KIRB., Syn. Cat. Diurn. Lep., 39 (1871).

Neorinopis sepulta BUTL., Lep. Exot., 127, pl. xlviii, fig. 3 (1873); IB., Geol. Mag., x, 3, pl. i, fig. 3 (1873).

The earliest notice of this fossil butterfly, the first species ever described and illustrated, the most perfectly preserved and the best known to the world at large, was given by Marcel de Serres in 1828, in the Annales des Sciences Naturelles; and in 1829 in his Géognosie des terrains tertiaires; where he simply cites on the authority of some one else the occurrence in the beds of Aix of a butterfly belonging to "la division des Satyrus."

The earliest definite mention of the insect is given by Duponchel in the Bulletin of the Entomological Society of France, as follows:[1]

"M. Duponchel entretient ensuite la Société d'un fait extraordinaire, et peut-être entièrement nouveau dans les annales de [52] la science: c'est l'existence d'une impression très remarquable de Lépidoptère fossile, qui a été trouvée dans une plâtrière des environs d'Aix (en Provence), et acquise par M. de Saporta. Ce Lépidoptère, suivant M. de Saporta, paraît appartenir au genre *Nymphale*, et à une espèce étrangère à celles qui vivent aujourd'hui en Europe. Le corselet en est parfaitement conservé; les couleurs des ailes sont très-bien indîquées; le dessin de ces ailes est entièrement reconnaissable. Les deux ailes d'un des côtés du corps sont repliées en grande partie l'une sur l'autre; la place du ventre est très distincte; l'autre côté manque tout-à-fait."

The subject seems to have been referred to Dr. Boisduval, for we find in the following year[2] that

"M. Boisduval rend un compte verbal du rapport que la Société l'avait chargé de faire, sur un dessin envoyé à M. Audouin, par M. de Fonscolombe, et qui représente une empreinte de lépidoptère fossile trouvée dans les environs d'Aix. M. Boisduval déclare, qu' après un examen attentif, il a reconnu que ce lépidoptère devait appartenir à son genre *Cyllo*, et qu' il se rapprochait beaucoup des espèces décrites par les auteurs sous les noms de Satyrus Europa, Caumax, Rhosia et plusieurs autres lépidoptères indiens. Le même membre ajoute que ce *Rhopalocère* ne peut se rapporter exactement à aucune des espèces vivantes déjà connues. Toutefois, avant de décider si cet insecte doit être regardé comme un véritable fossile, M. Boisduval pense qu'il serait indispensable, que la Société pût avoir sous les yeux [12] la pierre qui a servi de modèle au dessin envoyé par M. de Fonscolombe."

The next year a very fair illustration of the insect, reproduced in our Plate I, fig. 17, was given, and shortly afterward a written report upon the subject by Dr. Boisduval, in which he furnishes, not only his views upon its affinities, but a brief historical account of the insect, which is given below:[3]

"Il y a bientôt un an que je fus chargé par la Société d'examiner le dessin d'un Lépidoptère fossile trouvé dans les plâtrières des environs d'Aix en Provence, et appartenant à M. le Comte de Saporta. Au premier coup d'œil, ce dessin me parut devoir être rapporté à une espèce de SATYRIDES du genre *Cyllo*, à côté des *Satyrus Rohria*, *Caumas* et *Europa*, de l'Encyclopédie; mais la découverte d'un

[1] Bull. Soc. Ent. France, 1838, 51-52.
[2] Bull. Soc. Ent. France, 1839, 11-12.
[3] Annales Soc. Ent. France, ix, 371-374 pl. 8.

Lépidoptère fossile me sembla un fait tellement neuf, et l'espèce si rapprochée de celles connues, que je n'osai pas faire de rapport avant d'avoir vu la pierre en nature. La Société partagea cet avis, et engagea M. Duponchel à écrire à M. de Fonscolombe pour lui faire part du doute de quelques membres sur l'authenticité de cette empreinte. Ce fut alors que M. le comte de Saporta, naturaliste fort distingué et propriétaire du fossile en question, m'écrivit la lettre que j'ai communiquée à la Société; lettre dans laquelle il prétendait qu'il n'avait pu être victime de la supercherie de qui que ce soit, et [372] que par conséquent il n'y avait pas lieu à conserver le moindre doute sur l'exactitude scrupuleuse du dessin communiqué par son beau-pére, M. le Baron de Fonscolombe; qu'on pouvait voir d'ailleurs au Muséum un Polyommate fossile qu'il avait envoyé depuis plusieurs années avec des empreintes d'insectes de différents ordres.

Cependant la Société emit de nouveau le désir de connaître en nature ce lépidoptère fossile. M. Duponchel écrivit une seconde fois à M. de Fonscolombe: ce fut alors que M. le comte de Saporta consentit à se dessaisir pour quelques jours de ce précieux échantillon en nous l'envoyant en communication.

Le morceau de calcaire qui porte reéllement *l'empreinte parfaite* d'un lépidoptère conforme au dessin de M. Fonscolombe, est un fragment assez volumineux de marne gypseuse bituminifére, telle qu'on en rencontre dans une grande partie des environs d'Aix en Provence. . . . . .

Le Lépidoptère qui fait le sujet le ce rapport fait partie d'un [373] de ces genres dont les espèces assez peu nombreuses sont confinées aujourd'hui dans les îles de l'archipel indien ou dans les contrées les plus chaudes du continent asiatique. D'après ce que j'ai pu apprendre de M. Blum de Leyde, ils voltigent çà et là à l'entour des palmiers, dont peut-être ils se nourrissent à l'etat de chenille.

L'individu communiqué par M. de Saporta, et que nous avons nommé SEPULTA, pour rappeler son origine antédiluvienne, appartient au genre *Cyllo*, et se rapproche de Rohria, Caumas et autres espèces voisines; mais il ne peut être rapporté à aucune de celles connues de nos jours, ce qui est d'autant plus vraisemblable, que les marnes schisteuses sont de beaucoup plus anciennes que la dernière catastrophe diluvienne admise par tous les géologues.

Le dessin et la forme de cet insecte sont si bien conservés, que l'on croirait qu'il a été lithographie sur un schiste; seulement il n'existe que le côté droit, lequel est parfaitement intact, une portion du corselet et une légère empreinte de l'abdomen. L'aile supérieure est en grande partie cachée par l'inférieure, et il est impossible de dire si elle offre d'autre dessin qu'un œil apical surmonté d'un point blanc; l'autre, dont on voit toute la surface, est d'une couleur gris brunâtre, comme dans les espèces voisines, avec une tache costale blanche, une bande transverse, médiane, sinuée, de la même couleur, suivie de deux yeux noirs

encadrés de blanc, s'alignant extérieurement avec deux points blancs. L'extrémité de cette même aile est un peu plus pâle, presque blanchâtre, et divisée, comme chez la plupart des espèces vivantes, par deux lignes marginales brunes, parallèles. L'appendice caudal est un peu plus long que dans *Rohria*, mais situé de la même manière.

M. le comte de Saporta a émis plusieurs opinions géologiques sur la cause qui a produit les empreintes d'insectes dans les terrains des environs d'Aix. . . . .

[374] Il admet . . que ces marnes ont été formées couches par couches, ou plutôt feuillets par feuillets, par des dépôts fluviatiles. . . . . Selon certaines circonstances, les différentes couches ont varié de couleur, comme on peut s'en convaincre par l'échantillon que la société a eu sous les yeux. Les plus inférieures sont colorées par du bitume et des oxydes métalliques; celle où se trouve le Lépidoptère est blanche et presque pure, ce qui permet de distinguer le dessin et probablement la véritable couleur du papillon tel qu'il était avec son incrustation."

The plate accompanying the Report of Dr. Boisduval has been several times copied,[1] and his statements reproduced in part or referred to, as will be seen by the Bibliography at the commencement of this essay.[2] But the most extraordinary of all is an acute criticism by Lefebvre, eleven years subsequently, of which I give the following extracts,[3] from a copy of the paper in my possession slightly corrected by the author.

" [72] Si de l'œil on suit les bords de la seconde aile [Pl. I, fig. 17] qu'avec le docteur je reconnais couvrir en grande partie la première, je trouve qu'elle est, cette seconde aile, totalement arrondie dans ses contours, et je ne peux concevoir par quelle aberration d'optique il lui a vu la moindre analogie avec la seconde aile d'une de nos *Cyllo;* comment il lui attribue un appendice caudal, propre volontiers aux [73] espèces de ce groupe, et qui, selon lui, la termine à la manière de ceux de la *Cyllo Rohria* de Fab. (Voy. f. A [Pl. I, fig. 14]).

Pour parler ainsi que le fait M. Boisduval de cet appendice, il faut nécessairement qu'il ait confondu avec cette seconde aile le dernier contour de la première, qui l'excède à partir de leur point de jonction sur le bord externe, lui attribuant comme appendice caudal cette forte dent de la première aile, qui succède à une forte échancrure, ainsi qu'il en existe dans tant de Vanessides, et qui le plus souvent y est soutenue par la troisième inférieure, ainsi que tout à l'heure elle l'y sera pour nous dans la *Sepulta.*

J'avoue donc que je ne puis, avec le meilleur vouloir, envisager cette em-

[1] By Marcel de Serres, Actes Linn. Soc. Bord., Vol. xiii, pl. 2; Pictet, Traite de Palaeont., II pl. 40, fig. 11; Butler, Lep. Exot. I, pl. 48, fig. 2; Ib., Geol. Mag. x, pl. 1, fig. 3.

[2] See particularly papers by Coquand, Marcel de Serres, Heer, Saporta, Giebel, Westwood and Butler.

[3] Ann. Soc. Ent. France (2) ix, 71-88 pl., 3, ii.

preinte autrement que je ne le fais, et que pour la considérer sous le même point de vue que notre docte confrère, il me faut faire trop violence à mes pauvres yeux . . ; il me faut enfin donner un démenti aux contours si bien écrits de ces deux ailes superposées. . . .

Et, en effet, ne voit-on pas se dessiner les bords de la première aile dans tous leurs contours; la transparence de la seconde, avant son angle anal, ne permet-elle pas de suivre encore le bord inférieur de la première, qui est un peu falqué et qui, dans l'empreinte, passe précisément sous l'articulation femoro-tibiale de l'unique patte postérieure qui existe encore?

Toute la seconde aile ne vient-elle pas de ses bords nettement tranchés, et surtout dans le bord extérieur, couper toute la première aile sur laquelle elle est appliquée? A partir du point le plus proche de ce même bord [74] avec celui de la première aile, et presque au centre de sa forte échancrure, ne s'en détache-t-elle pas, comme au-dessus, par une marge obscure et très nettement tracée? Enfin, cette même aile ne se continue-t-elle pas seule et détachée sur le fond de la pierre, avec ses méplats voulus dans les bords postérieur et abdominal, jusqu'au-dessus du fémur de la patte déjà citée?

Je ne crois pas qu'on me puisse répondre par la négative, tant les faits sont patents.

Cet examen nous donne donc pour résultat:

1° Une aile de dessus fortement dentée et échancrée en dehors, à son bord extérieur. (Voy. fig. B [Pl. I, fig. 16]).

2° Une aile de dessous, simple, arrondie, et sans vestige d'appendice caudal.

Si c'est chose convenue, qu'en déduire? Si ce n'est que par cette seule conformation, nous sommes actuellement en droit de décliner déjà toute espèce d'analogie entre la *Sepulta* et le genre *Cyllo*, proprement dit, et de l'éloigner des *Caumus*, *Beroe*, *Rohria*, et autres; et cela, d'abord, par la rondeur inerme de la seconde aile, et ensuite à la première, par cette forte échancrure, suivie d'une dent non moins énorme que soutient la troisième inférieure, caractères que n'offrent guères les Satyrides de cette section, et où la dent la plus proéminente du bord extérieur, comme à *Banksia* God., se prononce à l'extrémité de la première supérieure, quand il en existe une.

Je ne connais que des Vanessides qui puissent présenter en même temps des premières ailes déchirées de cette manière à leur bord extérieur, et des secondes ailes arrondies et sans dentelures. La *Van. Archesia*, Cr. pourrait, entre autres, nous en offrir un example. Et cependant chez les Vanessides, lorsque les premières ailes y sont ainsi dentelées et découpées, les secondes le sont égale-[75] ment, plus ou moins, par la règle assez générale qui veut que chez les Lépidoptères les secondes ailes y soient toujours plutôt munies de dentelures que les premières.

Voici donc, pour la forme des ailes, un argument en faveur de mon opinion. Passons aux dessins.

Avant que d'assayer de les réhabiliter dans cette espèce, il me faut décider une autre question, à savoir si ces dessins appartiennent à la première aile ou à la seconde. Notre confrère les tient pour être propres à cette dernière. Je ne suis pas de son avis, et voicé pourquoi:

Je pense que la seconde aile est en grande partie dénudée de ces écailles à sa face inférieure, celle que nous voyons.

Ce qui me le fait croire, c'est que déjà dans sa marge abdominale, ainsi que je l'ai déjà dit, on suit à travers la membrane le contour intérieur de la première aile, et d'une manière trop distincte pour admettre que l'adhésion des deux ailes le pût permettre, si les deux faces de la seconde étaient revêtues de leurs écailles.

Ce qui me le fait croire encore, c'est qu'à cette seconde aile, la petite lunule blanche de l'angle externe (fig. B [Pl. I, fig. 16]), qui est située sur le bord lui-même, et qui y est extérieurement coupée par lui, ne saurait devoir y exister à cette place, si on en juge par la loi suivie dans leur position normale parmi la majeure partie des Diurnes. En effet, à aucun, ou à bien peu du moins, je ne connais pas à cet angle de lunule extrême, ainsi placée sur *le bord lui-même* des secondes ailes, et dans cette position, rejetée en arrière de celle qui la précède.

Règle assez générale, la série marginale de taches lunulaires ou autres, pupillées ou non, qui affectent ces ailes, est d'habitude concentrique à leur base, et la lunule en [76] question serait sur cette seconde aile placée contre cette règle.

A examiner cette aile dans la fig. B [Pl. I, fig. 16], on comprend de suite que cette lunule n'y est pas à sa place normale; elle choque même là où elle est située, tandis que si je la reporte (sans la bouger, bien entendu) sous la première aile (ainsi que je le fais à la fig. C [Pl. I, fig. 15]), elle s'y adapte tout naturellement dans l'ordre que lui est le plus rationnel avec les autres.

Par ce fait, à la place qu'occupe cette lunule, la seconde aile serait donc encore transparente? Observons en passant que dans les espèces où une semblable lunule ou tache oculaire, se remarque en dessous, vers l'angle externe des deux ailes (comme à *Melanitis Undularis*, Dr.; *Protogenia*, Cr., *par ex.*), cette tache qui est toujours placée *un peu avant* la marge, qui ne *l'interrompt jamais* comme ici, est toujours (comme ici, du reste) entre les deux dernières supérieures, et non entre la dernière supérieure et la costale.

S'il est des exceptions à cette règle, elles ne sauraient être qu'en bien petit nombre, et lorsque les lunules marginales y sont présentes en nombre considérable; mais s'il n'y en a plus qu'une ou deux, celle de l'angle externe sera placée ainsi que je viens de la dire, et non ailleurs.

Toujours à l'appui de cette transparence, que j'attribue à la seconde aile de la *Sepulta*, si j'interroge le peu de la charpente alaire qu'on y distingue, et qui est suffisant pour la restituer telle qu'elle devait être, ou à bien peu de chose près (comme à la fig. C [Pl. I, fig. 15]), on voit que la tache semiorbiculaire et obscure

de l'angle interne y semble partagée par une nervule de la seconde aile très bien écrite, par la deuxième inférieure. Or, l'étude de cette partie de la [77] ptérologie, qui à pour objet les lois relatives à la position, à la forme, comme à la présence et à l'absence des dessins et des taches, nous apprend que jamais une lunule ou une tache orbiculaire marginale n'est divisée par une nervule, mais plutôt par le pli internervulaire, les nervules séparant d'habitude ces sortes de taches, et ne les scindant pas.

Par induction, je dirai donc que cette tache orbiculaire n'est pas encore ici à sa vraie place sous la seconde aile. Mais si je l'attribue à la première, ainsi que tout à l'heure je l'ai fait pour la petite lunule, à son tour elle s'y adapte marveilleusement bien (fig. C [Pl. I, fig. 15]), entre la troisième inférieure et la sous-médiane, et en plus, son rejet en dehors, qui nous choquait il y a un instant, n'a actuellement rien que d'assez normal.

Allant plus loin, si la grande tache orbiculaire, fort noire, qui la surmonte, et qui à la place qu'elle occupe sous la seconde aile peut y exister sans discussion, ainsi que l'autre petite lunule blanche qui se voit au-dessus, sont reportées à la première aile (fig. C [Pl. I, fig. 15]), elles viennent y compléter cet ensemble, qui paraît alors fort rationnel, des plus habituels, et dont au besoin nous trouverions un exemple dans la *Van. Alcithoe*, Cr., etc.

Et ici, il n'y a pas à s'y tromper les nervures encore existantes à cette seconde aile, sont bien représentées à leur place voulue, selon les lois de la Solénoptérologie.

[78] Or, si la nervule dont s'agit (la deuxième inférieure) est à sa place normale, la tache orbiculaire qu'elle divise n'y est pas. Donc, elle doit appartenir forcément à l'autre aile.

Puisque nous voici fixés sur la position plus que probable de ces deux autres taches de la seconde aile, convenons que pour les y maintenir il faudrait que cette aile eût précisément conservé ses écailles à cette place. C'est chose possible, mais chose peu probable.

D'après ce qui précède, je suis donc porté à croire, comme je l'ai déjà avancé, à la dénudation presque complète du dessous de cette seconde aile, et que l'action des eaux sédimenteuses qui a agi sur cette face, vu l'adhérence de toutes les écailles à l'autre éclat de cette marne qui nous est inconnue, n'a pu atteindre les portions de la première aile qu'elle abrite.

En plus, par l'analogie et le faciès de la *Sepulta*, ayant tout lieu de penser que le dessus de toutes ses ailes devait être d'un brun sombre, uni et privé de tout dessin tranché, ou varié de vives couleurs, par cela même, j'en induis [79] que la surface supérieure de la seconde aile n'a pu empêcher les dessins qu'elle recouvrait de paraître, sans confusion aucune, à travers la couche unicolore des écailles du dessus, généralement très fines dans les Satyrides. Leur

adhérence intime à la surface inférieure de la première aile aura même dû augmenter la transparence de la seconde.

Mais avec assez de raison, on pourrait me demander à mon tour, par quel privilége, ce qui reste de non recouvert de la première aile n'a pas été altéré par ce même frottement, ou plutôt par son impression sur l'éclat qui a mis à jour cette empreinte? De cet argument *ad hominem*, je ne pourrais me tirer je l'avoue, qu'en arguant que nous ne voyons que par transparence les taches et dessins, fort admissibles, de la face supérieure.

Par ce que je vais ajouter encore, on pourrait en déduire que selon le besoin que j'ai de la dénudation, ou de *l'intactum* des écailles du dessous de cette deuxième aile, je les admets ou les repousse pour mieux soutenir l'opinion que j'avance. . . . . .

Il est de fait que par la marge obscure de la seconde aile qui se découpe si nettement sur la première, je suis forcé de reconnaître que les écailles de ses bords ont dû y être plus respectées, peut-être, qu'ailleurs, pour nous apparaître encore avec une pareille vigueur; mais peut-être aussi la concordance d'une semblable marge en dessus, et qui n'aurait rien que de normal, concourt ainsi à [80] la rendre aussi visiblement nette que nous la voyons aujourd'hui?

De toute manière, il est impossible de l'admettre comme dessin appartenant au dessous de la première aile, ainsi qu'a dû le comprendre M. Boisduval, par une erreur d'optique, que déjà sans doute il a reconnu lui-même.

L'absence bien regrettable de l'éclat qui recouvrait cette *Sepulta* est cause de tant d'incertitude, car je ne mets pas en doute qu'il devait conserver, à son tour, la majeure partie des écailles de toutes ces ailes, avec lesquelles il était en contact.

Tant bien que mal, nous voici donc édifiés sur la portion extérieure de ces ailes. Continuons cet examen en marchant vers leur origine.

Je reprends le dessin original.

Après cette série de taches marginales, il existe sur la côte elle-même, avant l'angle externe de la seconde aile, une large éclaircie blanche, quelque peu ovalaire, nettement dessinée en dedans, et posée sur la place qu'à la première aile doit occuper la disco-cellulaire et le commencement des deux premières supérieures.

La position de cette tache blanche à la seconde aile n'a rien de réfutable, non plus que celle très obscure qui lui succède, puis l'autre tache blanche, et enfin la masse obscure qui couvre toute la base.

Ces dessins maculaires peuvent, à la rigueur, y exister, comme n'y pas être, de même qu'ils ne sont guère acceptables à leur autre surface; car ce que nous voyons est bien un dessous d'aile et non un dessus.

Les dentelures externes de la tache basale, sont en dessous des plus natu-

relles, et dans nos *Satyrides*, dans [81] nos *Vanessides*, nous en retrouvons de nombreux exemples.

Mais un instant, ne nous pressons pas de juger: examinons attentivement l'original: qu'y voyons-nous?

Déjà, sur le bord costal de la première aile, nous apercevons en effet, sur notre gauche, un commencement de cette blanche éclaircie qui succède aux lunules, et à notre droite, le bord intérieur de cette éclaircie y est des plus évident! (Voy. fig. B [Pl. I, fig. 16]).

Comment donc se fait-il que ces ailes ainsi ployées, ces vestiges de la première aile viennent s'adapter d'une manière si complète avec toute la portion blanche qui se continue sous la seconde aile? cela se peut rencontrer, je l'avoue, mais c'est peu fréquent.

Bien mieux, le large sommet de la tache blanche anguleuse et obscure qui lui succède, se voit aussi sur le bord un peu diffus de la côte, dans la partie externe, et se relie également bien avec celle que la seconde aile nous laisse, selon moi, apercevoir. Plus loin encore, le commencement de la grande tache basale, hachée à son dehors, ne se continue-t-il pas sur la côte de la première aile?

Enfin, si cette dernière tache appartenait à la seconde viendrait-elle, ainsi qu'elle le fait, s'arrêter précisément sur le bord intérieur de la première, que par transparence nous pouvons suivre parfaitement à partir du moment où il est recouvert par la seconde aile? En l'attribuant à cette dernière, ce serait agir contre toute apparence plausible, contre toute disposition naturelle de ces sortes de taches, et venir l'interrompre bénévolement et sans motifs spécieux, bien avant l'angle anal de la seconde aile, sur lequel elle devrait venir s'appuyer pour demeurer dans la forme la plus normale! [82]

Cette interruption nous fixe donc aussi bien que le commencement de toutes les taches du haut, sur l'attribution que nous devons en faire à la première aile, et non à la seconde, et le peu qui reste de ces divers dessins sous cette dernière, si toutefois il en reste, doit se confondre avec elles, sans contribuer beaucoup à nous egarer.

D'ailleurs, nombre de Lépidoptères diurnes des groupes, près desquels doit venir se ranger la *Sepulta*, présentent sous leurs premières ailes de semblables taches costales et basales, ainsi placées, ainsi dentelées, ainsi conformées; d'habitude même, elles y sont les vestiges plus ou moins complets de ces larges bandes transversales qui couvrent ces mêmes ailes d'une manière plus ou moins accusée; assez souvent elles vont se répétant sous les secondes ailes, et s'y continuent d'une manière parfois assez suivie, et selon l'expansion donnée aux ailes. Elles y sont même, à mon avis, un indice de celle que la nature a entendu leur accorder dans le vol, quand les bandes du dessous des deux ailes s'y rajustent bien exactement.

Voici donc les taches et les dessins qui, après nous avoir aidés à reconnaître la forme et la nature plus ou moins opaque de ces ailes, sont actuellement eux-mêmes contrôlés par la constitution physique de ces organes, restitués à leur places voulues, et sous l'aile qui les doit comporter.

Voyons actuellement si l'étude du système nervulaire viendra confirmer ou détruire ces suppositions. Cet examen anatomique a bien son prix actuellement qu'on en comprend mieux l'importance.

Avant tout, je dois reconnaître que ces précieux vestiges sont parfaitement indiqués là où ils doivent être, sur [83] cette copie de la pièce originale, et que le dessinateur nous les laisse suivre assez facilement, tant à une aile qu'à l'autre.

Que reste-t-il de la charpente alaire de la première aile? D'abord, des traces de la costale; puis, au-dessus de la lunule blanche de l'apex, les premier et deuxième rameaux des trois apicales qui doivent jaillir de la troisième supérieure. Diverses stries s'échappant du premier, accusent sans doute ici les restes d'un dessin perdu ou quelques plis anormaux; c'est sans importance. Puis, au-dessus de la lunule noire, on distingue fort bien la deuxième supérieure, et plus bas, enfin, la première.

Sur le bord extérieur, je devine encore l'extrémité des deux premières inférieures; à travers la seconde aile, un trait noir qui passe entre la lunule blanche et la large tache noire orbiculaire, m'indique bien la position de la deuxième inférieure; enfin, je suis non moins facilement, entre les deux taches noires orbiculaires, la troisième inférieure, un peu moins accusée.

Ces deux nervules se relient visiblement à la portion très lisible de la médiane qui, sur le dessin, coupe le bas de la première tache blanche costale.

Toujours à la première aile, la troisième inférieure s'y reconnaît parfaitement à la place voulue, au milieu de la dent qu'elle soutient. En effet, le plus souvent, quand une dentelure, pareillement située, affecte le bord extérieur des premières ailes, ainsi qu'on le peut remarquer dans les *Van. Progne*, *Archesia*, *L.-album*, *Anglica* et autres, cette troisième inférieure a la prérogative de lui servir de support.

Au-dessus de son extrémité nous voyons un faux trait, sans doute, car la présence d'une nervule me paraît impossible à cet endroit. Plus bas, au dessous d'elle, le pli [84] qui, selon moi, doit traverser la tache orbiculaire la plus inférieure, précède encore un trait, sans valeur à mes yeux, puisqu'il m'est inanalysable; et, en définitive, on voit la sous-médiane qui se projette à travers la seconde aile, se confondant avec les traces de la seconde inférieure de cette dernière.

Plus bas, avant l'angle interne, un autre léger faux trait me semble encore inexplicable, car la saillie dentée de la marge au dehors, précise assez la place, qu'à la première aile, doit occuper l'extrémité de la sous-médiane qui d'habitude reste volontiers assez distante de la médiane. En plus, il ne saurait exister ici d'inter-

médiane, dont la présence ne se révèle que dans les tribus trop éloigneés de celle dont la *Sepulta* fait partie, pour nous en préoccuper ici.

La nervulation de notre première aile se trouve donc ainsi être au complet, ou à peu près, et déjà je la peux réhabiliter avec le crayon, telle qu'elle doit être.

Passons à la seconde.

La côte seulement se soupçonne, on voit parfaitement comme des traits blancs, la costale qui est ici très brève en son trajet; puis la sous-costale, la médiane, et le dé-[85] part des trois supérieures qui se relient très bien en blanc sur la marge dentelée de la tache basale (la deuxième moins facilement).

Ensuite vient la médiane, dont on suit le parcours, ainsi que sa ramification qui forme la première inférieure et qui passe sous la plus grande des deux taches orbiculaires; puis la deuxième (celle qui, contre toutes les lois de la Spiloptérologie, couperait la deuxième tache orbiculaire, si on l'attribuait à la seconde aile).

Vient enfin la troisième inférieure, représentée, peut-être, par une forte ligne blanche, et qui doit s'attacher à la médiane, peu avant l'articulation fémoro-tibiale de la patte.

Dans les bords postérieur et abdominal, je ne peux distinguer ni la sous-médiane, ni l'interne, qui sont disparues dans la portion restante, et évidemment diaphane de cette aile qui se détache ici sur le fond de la pierre.

Maintenant, si sur le tracé de la charpente alaire, scrupuleusement calqué sur celui de la *Sepulta*, et que je donne ici (fig. C [Pl. I, fig. 15]) rétablie dans son entier; si, dis-je, on calque cette nervulation sur un papier végétal et qu'on reporte cette copie sur le dessin de la pierre originale, qui s'y verra par transparence, ou bien sur ceux de la fig. C, qui est l'insecte tel que je le comprends, on sera frappé de la précision avec laquelle ces diverses nervures s'adapteront au dessin et aux taches que j'attribue à la première aile, ainsi qu'aux vestiges de la charpente alaire de la seconde aile. Ainsi, on pourra facilement contrôler mes assertions.

Si donc la Solénoptérologie vient à son tour confirmer mes rectifications, je dois croire que si je me trompe, je ne m'abuse que de bien peu. . . . . [86] Maintenant . . . . . que faire de ce Diurne?

Comme plus haut je l'ai dit, c'est évidemment une espèce aux premières ailes fortement échancrées et dentelées, tandis que les secondes y sont arrondies et simples, à méplats bien accusés.

Avons-nous dans nos espèces vivantes quelques-unes qui nous offrent cette coupe peu commune, et dont les ailes des *Van. Archesia* et *Iphita* de Cramer peuvent nous donner un exemple?

Cette *Sepulta* me semble tenir beaucoup, tout bien consulté, et des *Vanessides* et des *Satyrides*, telles que nous les comprenons. . . . . .

Evidemment la *Sepulta* ne saurait être une *Cyllo* proprement dite. Serait ce donc une Vanesside? Si la forme des ailes s'y prête quelque peu, son faciès,

l'agencement des ses dessins alaires, me porterait à en faire avec M. Boisduval un *Satyride*, appartenant à un de ces genres inter- [87] médiaires de ces deux familles nombreuses, déjà si peu éloignées à leur état parfait. . . . . .

A essayer de caser cet insecte, j'abuserais à n'en pas douter de la patience du lecteur; cependant, en peu de mots, je pourrais lui faire observer (en ne nous occupant que de la première aile, la seule que nous connaissons, à mon avis) que la large tache basale qui se voit ici, comme à tant de Diurnes, est avec les autres dessins de sa robe, le propre de nombreux Satyrides de cette taile et de cette coloration, qu'avec justesse M. Boisduval reconnaît devoir être d'une teinte terreuse, seulement variée de blanc et de noir.

La petite lunule noire me ferait penser qu'en dessus il devait exister une tache oculaire, dont elle est la simple répétition en dessous, et précisément à l'endroit (entre les première et deuxième supérieures) où cette tache existe le plus habituellement dans nombre de Satyrides de ce faciès, quand elle y est unique.

Certes, il devait y avoir en dessous, le long du bord extérieur et jusque dans l'apex, une série disparue d'arceaux internervulaires, formant une double ligne marginale, ainsi qu'elle se voit encore entre la dent et l'angle interne.

La nervulation si peu différente parfois entre nombre de Satyrides et de Vanessides, ne permet pas, sous ce rapport, d'assigner un poste bien fixe à la *Sepulta;* en plus, l'état de son empreinte ne nous permet pas de savoir si la base de ses nervures est affectée, en tout ou partie, d'entre elles, de ces renflements vésiculeux si communs à divers groupes de Satyrides. [88]

Nous ne savons rien non plus de l'absence ou de la présence des discocellulaires, et la perte assez prompte de la costale aux deux ailes, dans la côte, s'accorde moins avec la marche plus volontiers prolongée de cette même nervure dans les Satyrides, de l'apparence de la *Sepulta*, etc., etc.

Bref, m'abstenir pour décider rigoureusement de quel genre elle peut être, ou même approximativement, est ce que j'ai de plus prudent à faire; mieux que moi, d'autres lépidoptéristes pouvant s'acquitter de ce soin. Et à ceux qui, fatigués de tant de lignes sans ce résultat désiré, me diraient: "Concluez donc," je répondrais—je ne sais pas! . . . . . .

Explication des figures de la planche.

A [reproduced in our Pl. I, fig. 14]. *Cyllos epulta*, telle qu'elle a été comprise par M. le docteur Boisduval, en attribuant un appendice caudal à la deuxième aile.

B [reproduced in our Pl. I, fig. 16]. *Sepulta*, telle qu'elle devrait être d'abord comprise sous le rapport de la forme des deux ailes.

C [reproduced in our Pl. I, fig. 15]. *Sepulta*, telle qu'elle doit être jugée, tant pour la forme des ailes que pour la distribution de leurs dessins et leur nervulation, selon M. A. Lefebvre.

To this Dr. Boisduval at once responded, in the following language:[1]—

M. Al. Lefebvre, après avoir étudié avec soin la position des nervures, la disposition des écailles et celle des taches, ... est arrivé à conclure que j'avais pris l'aile inférieure pour la supérieure, et que cet appendice caudal, si manifeste dans l'espèce en question, était au contraire un angle appartenant à l'aile antérieure. Pour donner plus de poids à cette opinion, il a refait une planche où il ressuscite à sa manière notre *Cyllo sepulta*. Avec la queue que nous avons attribuée avec MM. Boyer de Fonscolombe, de Saporta, Duponchel, et avec tous les entomologistes qui ont vu l'échantillon à l'aile inférieure, il fait un angle très aigu d'une saillie tout à fait insolite, qu'il place au milieu de l'aile supérieure, tandis qu'il a fait une aile inférieure complètement arrondie. A côté de celle figure, il en donne une autre où il développe notre *Cyllo* comme il prétend que nous l'avons compris. J'en demande bien pardon à non estimable ami, mais jamais je ne l'ai compris de cette façon. Je conviens du reste que cet intéressant Lépidoptère fossile serait bien plus antédiluvien tel que M. Alexandre Lefebvre le représente, que comme nous le supposons, car nous ne lui trouverions aucun analogue, attendu que jusqu'à présent nous n'avons jamais vu une seule espèce avec des ailes supérieures anguleuses et appendiculées, et des ailes inférieures arrondies comme avec un compas, il faut croire que la nature n'en produit plus. Nous avons toujours observé au contraire que lorsque les ailes supérieures étaient anguleuses, les ailes inférieures l'etaient aussi d'une manière très manifeste; mais ce que personne de vous ignore, Messieurs, c'est que très souvent au contraire les ailes inférieures, surtout dans le genre dont il est ici question, présentent des appendices caudiformes plus ou moins saillants, et que parfois les ailes supérieures ont leur contour simplement sinué. A l'appui de son opinion d'ailes inférieures arrondies, aves des supérieures anguleuses, notre collègue a cherché à trouver un exemple dans les figures de Cramer, et il cite en consequence la *Vanessa* [98] *Archesia* qui effectivement présente cette forme; mais Cramer a figuré un individu mutilé, que probablement on avait arrondi avec des ciseaux, car nous en possédons un très bel exemplaire, pris par M. Drege au pays des Hottentots, que nous mettons sous les yeux de la Société, afin qu'elle s'assure bien qu'au contraire cette espèce est une des plus fortement appendiculée. Le choix de cet exemple est malheureux. Nous persistons donc tout à fait dans l'opinion que nous avons emise lors de la publication du rapport qui nous a été demandé.

Sometime subsequently Mr. A. G. Butler refers to this dispute between the two French writers in the following manner:[2]

This very interesting species was described and admirably figured by Dr. Boisduval in the French "Annales de la Société Entomologique" (1840); that

[1] Bull. Ent. Soc. France, 1851, 97–8.

[2] Cat. Satyr., 189–190.

gentleman considered it to be a Satyride allied to *Satyrus rohria, caumas*, etc.,[1] which it somewhat resembles in the form of the wings.

In the French "Annales" (for 1851) M. Lefebvre published a note upon the species, in which he criticised Dr. Boisduval's paper, and stated that the fossil species, instead of being allied to *rohria*, was evidently a *Vanessa*—that the strong, tail-like projection belonged to the front, and not to the hind wings, and represented the angular projection which occurs in all true Vanessidæ, as an example of which he instanced *Vanessa* (*Junonia*) *Archesia* of Cramer. This remarkable note was, moreover, accompanied by figures of the species, representing the tail both upon the front and hind wings.

In the same volume of the "Annales" Dr. Boisduval gives an excellent answer to M. Lefebvre's observations, in which he well remarks, "Nous n'avons jamais vu une seule espèce avec les ailes [190] supérieures anguleuses et appendiculées, et les ailes inférieures arrondies comme avec un compas;" and certainly, did such an insect ever exist, its wings would be utterly useless as organs of flight, for they would invariably carry it downwards. In all insects which have small and rounded hind wings, the costa of the front wings always far exceeds the inner margin in length and strength,[2] whereas in M. Lefebvre's insect the reverse would be the case.

It should be borne in mind, however, that there are two distinct criticisms by Lefebvre, to the second of which Boisduval only alludes in the most general way, and does not meet, while Butler makes no reference to it at all. As far as regards the position of the tail, Lefebvre is unquestionably wrong (see Pl. I, fig. 10), although his fault is primarily due to the inaccuracy of the engraving given by Boisduval, an inaccuracy which is slightly accentuated in our copy of it (Pl. I, fig. 17). But by far the larger part of his paper is made up of a detailed argument, drawn from the position and character of the markings and from the direction of the nervures, in which he endeavors to prove, and in most cases really does prove (though he errs in some of his statements concerning the neuration), that these markings belong to the front and not to the hind wing. He argues, for instance, that the two oval dark spots are plainly traversed by the nervures of the hind wing, and therefore cannot belong to that wing; that the minute white spot apparently on the outer border of the hind wing is only half a spot and must belong to the fore wing, and that the markings on and near the

[1] Species of Lethe.

[2] As, for instance, in the *Sphingidæ*, *Heliconidæ*, etc.

costal border traverse both wings and must belong to the one to which they certainly belong in part, the front wing. To this Boisduval makes no sort of answer, and Butler, to judge from his silence in the matter, and the comparative illustrations he gives on a plate published subsequently,[1] considers it unproven. All of these writers are, however, entirely wrong in supposing that the under surface of the wings is exposed to view, and that the hind wing covers the front wing. Boisduval does not distinctly state this; but the whole tenor of his remarks shows that this was the view taken by him; and when Lefebvre says: "Si de l'œil on suit les bords de la seconde aile, qu'avec le Docteur je reconnais couvrir en grande partie la première," no objection is offered in Dr. Boisduval's response; nor does he demur to Lefebvre's statement, when the latter speaks of the "face inférieure, celle que nous voyons." As we shall show later, however, the upper surface of the wings is that exhibited on the stone, and the front wing almost entirely conceals the hind one; compare Pl. I, fig. 13, drawn anew from the fossil.

In the same place to which we have just referred Mr. Butler adds the following remarks on the probable affinities of this fossil:[2]

The true position of *C. sepulta* is undoubtedly in the family *Satyridæ;* and, so far as can be judged from the beautiful figure in the "Annales,"[3] it is exactly intermediate in character between three nearly allied genera now existing, viz.:— *Neorina*, *Antirrhœa* and *Anchiphlebia*, its more immediate allies being the commonest species in each of the above genera. Its characters are distributed between these three species as follows:—

	Neorina Lowii, Boisd.	*Antirrhœa Philoctetes*, Linn.	*Anchiphlebia Archæa*, Hübn.
Form of front wings,	*		
Form of hind wings,		*	
Tails of hind wings (intermediate in character between),	*	*	
Submarginal spots of front wings,	*	*	*
Black disco-submarginal spots of hind wings,		*	
Pale costal and discal banding of wings,	*?		*
Limitation of dark dentated basal area of hind wings,			*
Submarginal line of hind wings,	*		

[1] Lep. Exot. pl. 48.
[2] Loc. cit., p. 150.
[3] In this figure the neuration has not been very clearly defined, the veining of the hind wings not being continuous.

The venation appears to be nearly similar to that of Anchiphlebia. It is doubtful, however, whether the drawing of the veins has been sufficiently attended to, to offer any reliable characters.

In this paper he quotes Boisduval's locality "Aix en Provence," but when he next refers to this insect[1] he gives it as from "Aix-la-Chapelle, White sandstone," a mistake, however, corrected subsequently. In this latter paper he remarks:

I have discussed the position of this species in my catalogue of Satyridæ, pp. 189, 190; showing that its nearest ally is *Neorina Lowii*, a common Bornean species, but that it also has a slightly more distant relationship to *Antirrhœa Philoctetes* and *Anchiphlebia Archœa*, two common tropical American forms; the amount of affinity, as regards the first two of these species, may be seen on my plate, figs. 4 and 5; the resemblance to Anchiphlebia is less striking, and the affinity more doubtful; it has nothing to do with Cyllo.

That Butler should have so nearly pointed out the exact affinities of this insect from the simple study of Boisduval's plate, is unquestionably due to his extended familiarity with butterflies, and especially with the forms of this subfamily; but it also shows the essential harmony between the markings of the under and upper surface of the wings of butterflies, notwithstanding their frequent great dissimilarity; for Butler compares this fossil with the recent forms on the assumption that the under surface of the wings is seen in Boisduval's plate.

The actual condition of the fossil, for an opportunity of examining which I am indebted to the courtesy of Count Saporta, is this (see Pl. I, fig. 13): The thorax, hind legs and both pair of wings of the left side are preserved, almost completely; all the rest is lost. The thorax is viewed from above and somewhat on the left side; the hind coxæ seem to be almost torn away from their immediate connection with the trunk. The two hind legs are stretched out bent at the femoro-tibial articulation; the left leg lies above both the wings and is apparently attached throughout, although its base is covered a little by the crushed body; the right leg lies below both the wings and is apparently partially detached, though but slightly, from the coxæ; the tibio-tarsal articulation can be distinguished (Pl. I, fig. 11) but not the tarsal joints. The wings are bent over

[1] Lep. Exot., 127, pl. xlviii. Geol. Mag., x, 3, pl. i.

downward in a position the reverse of that of repose. The fore wing covers the hind wing as in nature, but to such an extent as to conceal the greater part of it; the guttered portion of the inner margin of the hind wings is almost fully expanded, but apparently has a fold next the submedian nervure. The fringe of the fore wing seems to be gone, but that of the hind wing is preserved nearly throughout. Head, fore and middle legs, wings of the right side and abdomen are wholly wanting.

The upper surface of the wings is, therefore, the part which attracts most attention. That it is the upper and not the under surface which is exposed to view is shown by the relation of the wings to each other (Pl. I, fig. 10), by their unquestionable attachment to the thorax, of which we certainly see only the upper portion with its smooth arched dome marked by the sutures which separate the portions which compose it; and by the design itself of the wings, which is such as pertains to the upper rather than to the under surface of butterflies of this group. These markings are most wonderfully preserved; and the careful and prolonged study I have given every part of the fossil has enabled me to separate, with a considerable degree of certitude, the markings which appertain to the fore wing and those which belong to the hind wing. Those of the latter are generally to be traced through the semi-diaphanous fore wing and are given in Pl. I, fig. 8. One is aided greatly in this investigation by following the lines and series of markings which extend over both the exposed and covered portions of the hind wing; and then by comparing the fainter and obscurer tints of the covered portion with equivalent marks on other parts of the stone covered by both the wings; in this way the markings of the hind wing may be separated from those of the front wing, but subject, certainly, to some degree of doubt. In the figure upon the plate (Pl. I, fig. 8) the portions to which the least degree of doubt attaches are the outer halves of the two wings. I am inclined to consider these as almost absolutely accurate. The parts on the other hand which are more likely to be inaccurate are the basal halves of the median interspaces of the fore wing and the contiguous portion of the medio-submedian interspace. Assuming, however, that the drawing faithfully

represents the real markings of this extraordinarily preserved fossil, a detailed description of its features follows.

The basal portion of the fore wing (Pl. I, fig. 8) is very dark, and increases in intensity toward the border of the innermost light patch; the latter is bounded by a line running in a nearly straight course from the costal nervure, opposite the middle of the upper border of the cell, toward the middle of the apical half of the submedian nervure; but it extends slightly outward on reaching the lowest median nervule and just below this turns baseward and makes a large ovoid curve of an interspace's diameter, returning to its course when it has nearly completed the circuit and reached the middle of the medio-submedian interspace; the outer limit of this large pale patch, which crosses the cell and extends nearly to the middle of the lower median interspace, nearly follows a line running from the upper extremity of the inner border to and along the middle median nervule. Beyond this the upper half of the wing, half-way to the apex, is nearly as dark as the basal part, excepting in a large light patch which crosses the lowest two subcostal and the subcosto-median interspaces, is broadest in the middle, but twice as broad at the upper as at the lower extremity, and rounded throughout excepting at the angular upper basal corner; its interior margin is sharply defined, and is nearly parallel to the interior border of the inner light patch, extending in a straight line from the subcostal nervure midway between the origin of the first and second superior nervules to the upper median nervule, about as far from its origin as it is from the base of the first median nervule; the exterior border is powdery, strongly convex and, starting from the subcostal nervure midway between the bases of the second and third superior nervules, joins the other border on the last median nervule; this patch is twice as long as broad. Extending from the next to the lowest subcostal nervule to the internal nervure, parallel to the outer border, is a broad indistinct pale band, broadening below, and on either side merging indefinitely into the darker parts of the wing, separated from the light patches by only a narrow belt of dark scales, which becomes narrower and fainter in the lower half of the wing; at its broadest the pale band is a little broader than an interspace, and it con-

tains in its middle and at the middle of each interspace, as well as in the next to the lowest subcostal interspace, a series of large circular dark spots, of nearly or quite half the width of the interspaces in which they fall, often, and especially in the upper interspaces, enclosing a small black pupil; these spots are almost exactly parallel to the outer border, that in the lowest median interspace with its outer border at an interspace distance from it; with the exception of that in the lowest subcostal interspace, they are each surmounted interiorly by a much smaller circular light spot, the centre of which is near the circumference of the larger spot, so as to infringe upon it; with the exception of the uppermost, which is nearly as large as the spot on whose summit it is placed, the light spots are of nearly equal size and about one-third of an interspace in diameter; or if anything the two lower, seated on the largest spots, are smaller than the others; the wing must have been wrinkled between the nervules next the outer border, as shown by the dark lines running from the border to the centre of the dark spots. The outer edge and the apex of the inner are uniformly dusky and rather lighter than the other dark parts of the wing; the fringe is evidently lost.

The hind wing is very dark at the base, like the fore wing, nearly as far as the extreme tip of the cell; this dark area merges gradually into a lighter portion, which crosses the wing as a very broad equal band having its outer limit at a narrow, dark, regular belt, with ill defined outline, which crosses the wing subparallel to the general course of the outer border a little within the middle of the outer half of the wing; within this broad light band are two narrow transverse powdery streaks of dark scales, one extending from the extreme tip of the cell, and broadening a little in its course, running in a curve opening inward to the inner border; the other starting from the same point in an opposite direction, and passing in a sinuous course, with varying width, toward the middle of the basal two-thirds of the upper subcostal nervule, hardly separate from the outer limits of the dark base of the wing. The darkest part of the narrow band in the middle of the outer half of the wing has a regular curve and strikes the borders in the middle of their outer halves; there is a submarginal slender dark

streak, separated by scarcely more than its own width from the outer border, becoming narrower toward the costal and inner borders, and especially towards the costal; it is broken at the upper median nervule, where the upper portion joins a second broader band, separated by a space nearly equal to itself from the submarginal band; this leaves a nearly equal light band in the outer part of the wing, broadest above and reaching from the costal border, almost to the inner; along the middle of this belt is a series of six round dark spots and ocelli, one in each of the interspaces excepting the costo-subcostal; the largest is in the lower median interspace, and is a spot nearly as broad as the interspace, deepening toward the centre to a black pupil; the next largest, in the upper median interspace, is an ocellus with a black pupil, immediately followed by a pale annulus, again surrounded by a dark ring of equal diameter, the whole a little more than half the width of the interspace; next larger are two spots of less intense depth of color, one in the upper subcostal, the other in the subcosto-median interspace, about one-third the width of the interspace, the upper deepening, the lower becoming paler at the centre; the spot in the lower subcostal and the medio-submedian interspace are equal and smallest, about one-fourth the width of the interspace, and consist only of rather faint, powdery marks, a little darker towards their centres. The fringe of this wing seems to be preserved and is short, nearly equal, dark, resembling a repetition of the submarginal streak.

Length of fore wing, 37$^{mm.}$; breadth of fore wing, 20·5$^{mm.}$; length of hind wing, 31·75$^{mm.}$; length of tail, 4$^{mm.}$; distance of the base of the second superior subcostal nervule of hind wing from the divarication of the costal and subcostal nervules, 5·55$^{mm.}$; rows of scales in the subcostal region of the fore wings, ·075$^{mm.}$ apart; length of thorax, 5$^{mm.}$; of hind femora, 4·6$^{mm.}$; of hind tibiæ 4·8$^{mm.}$; of hind tarsi, 4·9$^{mm.}$.

Tertiaries of Aix, Provence, France; collection of Count de Saporta.

LETHITES Scudder.

Satyrites Scudd. (nec Blanch.-Brullé), Rev. et Mag. de Zool., 1871-72, 66.

The costal border of the fore wing (Pl. I, fig. 5) is gently and equably curved, the apex moderately acute but well rounded, the outer margin, except at its extremities, nearly straight, and the inner border straight or almost so; the outer border is a little shorter than the inner and about three-fifths the length of the costal margin.

The costal nervule terminates slightly beyond the middle of the costal margin, its basal two-fifths presenting a considerable and almost uniform expansion, which tapers rather rapidly at the tip, and reaches nearly to the middle of the upper border of the cell. The subcostal nervule is very slight on the basal half of the wing, closely connected with the posterior surface of the swollen portion of the costal nervure and only divaricating from that vein after the latter has lost its tumidity; it emits its first superior nervule at slightly more than three-fifths the distance from the tip of the bulbous portion of the costal nervure to the upper apex of the cell; its second at midway between the origin of the first and the tip of the cell; its third at midway between the upper apex of the cell and the origin of the fourth, which arises at about two-fifths the distance from the base of the third to the outer border of the wing. The first superior nervule terminates near the middle of the outer two-thirds of the costal border, the second midway between the apex of the first and third; the third terminates just above, and the fourth at or scarcely below, the tip of the wing. The first inferior subcostal nervule arises at a very short distance beyond the base of the second superior nervule, and curving rather strongly, terminates in the middle of the upper half of the outer border; the second inferior nervule is emitted from the first inferior as far beyond the base of the latter as that is beyond the base of the second superior nervule; at its origin it is directed inward as well as backward (forming the upper termination of the cell) and passes backward in a small, narrow and rather strongly curved bow, bent below more than above, beyond which it assumes a course

nearly parallel to the first inferior nervule; just beyond the arcuate portion it is connected by a rather long, straight, oblique nervule, directed considerably outward as well as downward, to the origin of the upper median nervule. The median nervule is slightly enlarged at the base, and diminishes gradually and regularly in size to its first divarication, which is scarcely beyond the middle of the cell; the origin of its middle branch is slightly nearer the origin of the basal than of the terminal nervule; the latter strikes the middle of the outer border. The submedian nervure is straight and not swollen at the base. The cell is three times as long as broad, and scarcely more than half as long as the wing.

The article from which the above is quoted, as originally written, closes thus:

"The neuration of the fore wing does not seem to me to accord sufficiently with that of any known genus of Oreades to admit of its being classed with them. It undoubtedly has close affinities with the characters of the genus Debis (=Lethe Hübn.) as laid down by Westwood and Hewitson, if we exclude therefrom, as we should, the *Papilio Portlandia* of Fabricius. It is not a little interesting to notice that these authors have arranged this group in immediate proximity to the genus Cyllo (=Melanitis Fabr.), in which Dr. Boisduval placed the fossil species from Aix, named by him sepulta. Nor is it less interesting to find that in both genera all the living representatives (even including those discovered since the publication of the 'Genera of Diurnal Lepidoptera') are natives of the East Indies; so that the fossil butterflies of Provence have their nearest living allies in the far East."

Although differing from Neorina (Pl. II, fig. 8) very strikingly in the form of the wing and the swollen base of the costal nervure, this genus has some striking points of agreement with that in the neuration of the fore wing. The nervure closing the cell indeed is straight in Lethites and strongly curved in Neorina, but, as there, two of the superior subcostal nervules arise before the tip of the cell, and the other two are thrown off at about equal distances between the apex of the cell and of the wing; the vein closing the cell meets the median nervure in both cases as far beyond its second divarication as that is beyond the first; the shape and proportionate length of the cell is nearly

the same in the two, but the costal nervure appears to be much shorter in Lethites.

With Lethe (Pl. II, fig. 6) and Debis (Pl. II. fig. 10) the fossil genus can better be compared, as far as the form of the wing, the dilated costal vein, and the position and direction of the straight vein closing the cell are concerned; but in both these genera only a single superior subcostal nervule is emitted before the apex of the cell; the form of the cell again shows rather closer affinity between Lethites and these genera, although the difference in these respects is but slight. It is by no means distantly related to Enodia, in which two subcostal nervules are emitted before the tip of the cell, but differs from it in the much greater and more abrupt swelling of the costal vein, and in the much greater distance beyond the second divarication of the median nervure at which the vein closing the cell meets this nervure. It even exhibits no small affinity to Cercyonis, and especially to those species in which there is little dilation of the median nervure; the costal nervure is swollen in precisely the same way, and the superior nervules of the subcostal nervure are much the same; but the form of the wing is strikingly different, and the lowest subcostal interspace much wider at the base, in comparison with the width of the base of the subcosto-median interspace, in Cercyonis than in Lethites; and this seems to be a character of considerable importance. It may be noted in this connection that the markings of the fossil must have closely resembled *Cercyonis Pegala*.

Its nearest ally among living European types would seem to be *Maniola Hermione*, in which the costal and median veins are about equally swollen. The neuration of Lethites agrees with this genus in much the same way as it does with Cercyonis, the comparative width of the interspaces beyond the cell being very different in the living genera from what it is in the fossil. In the form of the wing Maniola agrees much better with Lethites than Cercyonis does, but the costa is much more arched, and the cell is much the longer in Maniola; were there no obscure spot in the lower median interspace in the male of *M. Hermione*, the markings of the fossil would agree with it almost perfectly.

LETHITES REYNESII SCUDDER.

Plate I, figs. 2, 5.

Satyrites Reynesii SCUDD., Rev. et. Mag. de Zool., 1871-72, 66-72, pl. vii (1872); IB., Descr. Pap. Foss. 1-7, pl. (1872); IB., Geol. Mag. ix, 532-33, pl. xiii, figs. 2, 3 (1872); IB., Descr. Foss. Butt. 1-2, pl., figs. 2, 3 (1872); BROD., Distr. Corr. Foss. Ins. [*Satyrites Beynesii*], 8-9 (1873).

I give below the original of the first paper cited above, excepting the portion which was quoted under the genus.

In a recent examination of the rich collection of fossil insects from Aix, preserved in the Museum of the city of Marseilles, my attention was attracted by two little slabs containing the traces of a fossil butterfly. Although by no means so well preserved, nor so perfect as the remains of a butterfly from the same beds, described by Dr. Boisduval more than thirty years ago, a glance showed that it could not be referred to that species, since the costal nervure of the fore wings was greatly swollen. No such form having to my knowledge been described from these beds, Dr. Reynès, the accomplished director of the establishment, courteously placed the best specimen in my hands for closer study; and from it the following account and illustrations have been drawn. The second specimen is very imperfectly preserved, but since it exhibits in all its features an exact resemblance to similar parts in the better specimen it undoubtedly belongs to the same species.

The fossil (Pl. I, fig. 2) is a natural cast of a butterfly lying upon its side, the wings folded back to back, the legs extended as if hanging, the tongue uncurled and, with the antennæ, drooping in a direction similar to that of the legs. The right fore wing, which lies beneath, is pushed a little outward and also forward, even at its base, showing that the specimen must have been greatly macerated in very quiet water, before being covered by the deposits which have preserved its more essential features. The condition and position of all the parts also lead us to conjecture that it was swept into its final resting place by a gentle current, which left the slighter appendages lying in the direction of its final action.

It is evident that the object is a cast, for the veins of the wing which lie

uppermost on the stone are impressed as we see them on the upper surface of the wings of living Oreades, while those of the wing lying beneath (veins which are plainly covered by the impressed nervures where the two come in contact) are in relief, as seen on the under surface of the same butterflies; that is, we have here the reverse of what would be the case, were we examining a living butterfly in this position.

The parts before us are: a poorly preserved body, vague indications of the terminal palpal joint, an antenna (probably a portion only), an unrolled tongue, the hinder pair of legs and portions of the other pairs, the greater part of the two front wings and fragments of the base of the hind wings. Of the latter, no border remains and only the base of a few of the nervules, which give scarcely any additional information as to the pterology of the insect. The only portion of the margin of the front wings which can be determined with certainty is the most essential part, the apex and the upper half of the outer border of the left wing, enough to show that its general contour was similar to that of the European Satyrids of the present epoch; but throughout the remainder all the nervules can be exactly traced. This being then the best preserved portion of the insect, we will consider its structure in detail, subsequently adding whatever can be gleaned from the examination of the other parts.[1] [The account of the structural framework of the wing is given under the genus].

The basal two-thirds of the wing appears to have been more darkly clouded than the other portions, although in this fuscous area there is apparently a clearer space towards the upper, outer portion of the cell. There is also a distinct, darker, uniform and equal rounded spot in the middle of the outer two-thirds of the lowest subcostal interspace, nearly reaching the nervule on either side; in the specimen it appears to be broader than long by encroaching upon the next interspace in front, but this is evidently only apparent, the spots of the two wings (one of which I have stated to be a little in advance of

[1] It should first be premised that throughout this description the fore wing will be spoken of as if it were perfect; for so completely are the essential parts preserved that one may feel a strong degree of confidence as to the character of the remainder; scarcely any of the costal margin can be traced on the stone, and yet one may describe with nearly absolute certainty the point where the extremities of the costal and the first two upper branches of the subcostal nervures strike it. For those, therefore, who would follow the description with a severely critical eye, the illustrations we have given will correct any apparent overstatement of the text.

the other) being blended. The object is so well preserved that one can see throughout the parallel series of minute punctures forming the points of insertion for the scales, outlines of the latter of which I have failed to discover. The wing is 28·5$^{mm.}$ long, the tip of the cell being distant 15$^{mm.}$ from the base of the wing; the costal nervure is inflated for a distance of 6·5$^{mm.}$, and the extreme width of this portion is 1$^{mm.}$; the rows of punctures indicating the former insertion of the scales are ·12$^{mm.}$ apart.

Of the body itself nothing can be predicated, unless it be that the form of the abdomen and the appearance of its tip lead us to conjecture that the specimen was a female which had deposited most of her eggs, or in which they were but partially developed.

At the anterior upper extremity of the head is a dark prominence which seems to be the terminal joint of a palpus; it extends ·75$^{mm.}$ beyond the head and is of a nearly uniform width (·2$^{mm.}$), scarcely tapering, with a rounded tip. The basal portion of an antenna, 5$^{mm.}$ long, is slender and apparently begins to increase slightly and very gradually in size, as in the genus Œneis Hübn. A finely impressed line, 7·25$^{mm.}$ long, appears to be the unrolled, though slightly curved tongue.

One of the hind femora projects 2·5$^{mm.}$ beyond the body; its tibia and tarsi are stretched in a single line, at an angle with it, but as the tip of what is apparently the other hind femur strikes them beyond the tip of their own femur, it is impossible to say whether they do not overlap, or are not overlaid by, the tibia and tarsi of the opposite side; their united length on the stone is 5·6$^{mm.}$; but if both hind pairs are present, their probable length is 4·5$^{mm.}$. There are also some remnants of the other legs, but in so fragmentary and confused a state that nothing can be determined from them, nor anything surmised of the length or structure of the front pair.

In the illustration of the fore wing given in the Revue et Magazin de Zoologie (fig. B), and copied in the Geological Magazine (fig. 3), the artist neglected to mark the position of the spot upon the wing. This is given in

our Pl. I, fig. 5, which, as well as fig. 2, is taken from the originals of my former plate.

Tertiaries of Aix, Provence, France; Museum of the city of Marseilles.

NYMPHALES—NAJADES—PRÆFECTI.

EUGONIA HÜBNER.

Fore wings considerably more than half as long again as broad, the costal border scarcely bent at a little distance from the base, beyond that nearly straight to an equal distance from the tip, where it becomes more curved; outer border with the portion above the middle of the lower subcostal interspace very slightly concave, having a general direction at a very little less than a right angle with the central portion of the costal border, beyond suddenly receding at a little more than a right angle to the middle of the subcosto-median interspace, and continuing in a deep crenulate curve to just below the lower median nervure, where a prominent rounded tooth is found, and below which the border is excised, its angle rounded off; inner border very nearly straight, scarcely convex on the basal two-thirds. First superior subcostal nervule emitted a little beyond the middle of the outer two-thirds of the upper margin of the cell; the second a little more than half way from the origin of the first to the tip of the cell; the third midway between the tip of the cell and the origin of the fourth; the latter at three-fifths the distance from the tip of the cell to the apex of the wing; second inferior subcostal nervule arising scarcely one-third way down the cell; the cell considerably less than half as long as the wing, and three times as long as broad; middle of the basal curve of the last median nervule connected with the vein closing the cell.

The butterflies of this genus, which are generally above the average size, strongly resemble those of the genus Polygonia, in the form, color and design of the wings, but on the upper surface of the fore wings the costal markings are much heavier.

The above characters are wholly drawn from recent species of the genus.

EUGONIA ATAVA (CHARPENTIER) SCUDDER.

Plate I, fig. 1, 3, 7.

Sphinx atava CHARP., Acta Acad. Leop.-Carol., xx, 408–9, Tab. 22, fig. 4 (1843).

Vanessa attavina HEER, Insekt. Tert. Œning., ii, 177–79, Taf. 14, fig. 3 (1849); IB., Nouv. Mem. Soc. Helv., xi, 177–79, Tab. 14, fig. 3 (1850); GIEB., Deutschl. Petref., 644 (1852); IB., Faun. der Vorw., ii, 186 (1856).

Vanessa? atovina KIRB., Syn. Cat. Diurn. Lep., 185 (1872).

Nymphalis? atovina KIRB., Syn. Cat. Diurn. Lep., 648 (1872).

This was the second fossil butterfly known previously to the publication of Heer's Tertiary insects. It was first described by Charpentier as a Sphinx, in the following terms:[1]

Ungemein interessant, und ich möchte sagen, ein Unicum ist der in oben bemerkter Figur abgebildete Schmetterlingsflügel. Dass es ein solcher sei, zeigt sogleich der erste Anblick, so wie sich bei näherer Ansicht herausstellt, dass es unbezweifelt der Oberflügel einer Sphinx Art sei. Er ist in seiner Form nicht gut gehalten, sondern vorn etwas eingerissen, seine Zeichung ist aber bewundernswerth erhalten, und erinnert sehr an den fast im ganzen mittleren und nördlichen Europa vorkommenden *Sphinx Tiliæ*, doch ist er wohl specifisch von demselben verschieden. Die drei grossen dunklen Flecke, die sich von äussersten Vorderrande, fast bindenartig, über einen grossen Theil des Flügels ziehen, sind unstreitig die Reste ehemaliger Zeichung und Färbung des lebenden Thieres.

The remainder of his remarks apply only to the rarity of fossil remains of Lepidoptera. The illustration was very poor and is reproduced on Pl. I, fig. 3. The next notice of it is by Heer, who also examined the original type, refigured [see Pl. I, figs. 1, 7] and redescribed it in the following manner, referring it to the genus Vanessa, and changing slightly the specific name:[2]

Alis anterioribus lividis, basi, fasciis maculisque nigris. Long 16⅞ Lin.

Radoboj. Ein Oberflügel, dessen Innenrand aber nicht erhalten ist.

Charpentier hat diesen Flügel einem Sphinx zugesprochen und ihn mit dem Sphinx Tiliæ L. verglichen; allein schon die ziemlich stark gebogene Randlinie (vena marginalis) spricht gegen Sphinx, bei welcher Gattung sie bis über zwei Drittel Flügellänge fast gerade verläuft und dann erst gegen die Spitze sich zubiegt; ebenso aber auch das Geäder. Bei Sphinx haben wir nämlich ein

[1] Acta Acad. Leop.-Carol., xx, 408.

[2] Insekt. Tert. Œning. ii, 177–79.

geschlossenes Mittelfeld und der Ast der vena externo-media, welcher neben der Flügelspitze ausläuft, verästelt sich nicht. In der Form des Flügels, im Geäder und Färburg stimmt unser Schmetterlingsflügel, wie mir scheint, am besten mit der Gattung Vanessa F. überein. Wir bemerken nemlich, gerade wie bie den Vanessen, zunächst eine starke vena scapularis, welche weit vorn in die v. marginalis ausläuft; eine schwächere vena externo-media, welche noch näher der Flügelspitze mit dem Rande sich verbindet; diese bildet nach Innen zunächst einen Ast[1], der flügelspitzwärts in zwei weitere Aeste sich spaltet; der äussere von diesen läuft zur Flügelspitze, der innere aber trennt sich nochmals in zwei Gabeläste, welche zum Hinterrande verlaufen und von denen jeder in einen schwachen, stumpfen Zahn des Flügelrandes ausgeht. Auf diesen Gabelast folgen weiter nach Innen zwei Längsadern, welche am Grunde sich wahrscheinlich verbinden, und in die vena externo-media eingefügt sind. Diese beiden Adern (es sind diess die fünfte und sechste Ader von Herrich Schaeffer) gehen bei [178] den Vanessen getrennt bis zur v. externo-media hinauf und divergiren gleich, wie sie aus dieser heraustreten; wahrscheinlich ist diess beim fossilen Thiere auch der Fall, jedoch sieht man nur die Einmündung des äusseren Astes in die vena externo-media, indem der innere am Grunde ganz verwischt ist, wie denn überhaupt die Adern in Folge des starken Druckes, dem der Flügel unterworfen war, äusserst schwach hervortreten und nur mit Mühe zu erkennen sind. Die vena interno-media verläuft wie bei den Vanessen, sie sendet nämlich nach dem Hinterrande zwei Aeste aus, so dass im Ganzen drei Längsadern zuletzt in parallelen Linien nach dem Rande verlaufen. Die vena analis ist nur am Grunde angedeutet, indem der Innenrand grossentheils zerstört ist. Das Mittelfeld ist offen, wenigstens ist keine Spur eines Verbindungsastes zwischen v. externo- und interno-media zu finden. In allen diesen Punkten stimmt also das fossile Thier mit den Vanessen überein. Ebenso stimmt ferner der zackige Hinterrand, indem wir, wie schon bemerkt, an der Ausmündung des äusseren Gabelastes der v. externo-media kleine Zacken bemerken, wobei freilich zu bedauern, dass von dort an der Flügel zerrissen ist, so dass die Randbildung nur an jene kleinen Stelle bestimmt werden kann. In der Färburg zeigt der Flügel viel Uebereinstimmendes mit demjenigen der Vanessa Cardui L. Wir bemerken nemlich zunächst dem Grunde eine dunklere Stelle, welche fast bis zu $\frac{1}{3}$ Flügellänge hinausreicht; dieser dunklere Flügelgrund ist indessen wieder in der Mitte durch einige unregelmässige hellere Stellen unterbrochen. Auf diese dunkle Stelle folgt ein helles Querband von $1\frac{3}{4}$ Linien Breite, welches aber nicht bis zum Innenrande reicht, weingstens ist an der Stelle, wo die v. interno-media den ersten Ast aussendet, wieder ein, freilich sehr undeutlich umgrenzter, dunkler Fleck; auf dieses helle Querband

[1] Wahrscheinlich ist ausser diesem noch ein Ast da, der aber verwischt ist.

folgt wieder ein 3 Linien breites dunkles Querband, welches mit mittleren schwarzen Querband der V. cardui entspricht; bemerkenswerth ist, dass dieses bei der V. attavina von der Nahtseite her ebenfalls durch einen helleren Flecken getheilt wird, welcher helle Flecken nicht bis zum Aussenrand hinausreicht. Auf dieses dunkle Querband folgt wieder ein helles Band von 1¼ Lin. Breite, und darauf wieder ein dunkler, 3¼ Lin. breiter Flecken, der aber sehr kurz ist, indem weiter nach Innen an jener Stelle der Flügel wieder hellgelb braun gefärbt ist; auf diesen dunklen Flecken folgt wieder ein kleiner heller Flecken; weiter flügelspitzwärts ist der Flügel dunkelbraun gefärbt, welche Farbe allmählig heller wird, so dass der Flügelrand wieder hellbraun wird; die Zackenspitzen dagegen sind schwarz.

In der Färbung des Oberflügels stimmt also der fossile Schmetterling am meisten mit Vanessa Cardui L. überein, dennoch kann er nicht als analoge Art betrachtet werden, denn fürs erste war er beträchtlich grösser [179], fürs zweite ist die Randader stärker gebogen, zeigt eine regelmässige Bogenlinie, während sie bei Vanessa Cardui in mehr gerader Linie verläuft."

The only subsequent notice of this insect, not directly copied or abbreviated from the above is by Butler, who remarks[1]; "I think it just possible, from the great resemblance which *V. Attavina* of Heer bears to the under surface of *J.* [*unonia*] *Hedonia*, that it is the reverse of *J. Pluto*."

I have been unable to see this fossil, or even to find out where it is preserved. Charpentier states that he received it for description from Dr. Unger through Professor Göppert of Breslau. Heer makes no mention of the quarter whence he received it. Herr Brunner von Wattenwyl searched for it in vain in the Vienna Museums.

All that can be said, therefore, must be drawn from the illustrations and remarks of Professor Heer. These seem to me to leave no doubt that the insect must be placed in Eugonia, and that it was a little larger than the European vau-album or our own j-album. A comparison of the neuration of *Eugonia j-album* (Pl. I, fig. 4) with that of Heer's figures of the fossil (reproduced on Pl. I, figs. 1, 7) shows that the last divarication of the subcostal nervure of the fore wing, and the points of termination of the last two superior nervules and of the subcostal nervure itself are essentially the same in both; while the position of all the markings on the fossil, allowing for its natural defects, are quite the

[1] Lep. Exot. I, 128.

same in position, direction and intensity, as in *E. j-album* (Pl. I, fig. 6). The same may be said of the form of the wing, as far as it can be seen, but as this is true only of the costal margin, and the merest fragment of the outer border, it cannot be considered to have much weight in itself; still, taken in connection with all the other features, which agree almost wholly with those of Eugonia, and but partially with its near ally Vanessa, to which Heer compares it, we must refer the fossil to Eugonia, at least until a new examination of the fossil shall give us further facts as a basis for an opinion. This is the position dubiously assigned to it by Kirby, in his Synonymic Catalogue.

Tertiaries of Radoboj, Croatia.

PAPILIONIDÆ—DANAI—FUGACIA.

MYLOTHRITES Scudder.

Of the form of the fore wing (Pl. II, figs. 7, 17) we can say but little, from the imperfect nature of the fossil; the costal margin, however, is very regularly and rather strongly arched, and the direction of the middle portion of the outer border (probably at a right angle, or at a little less than a right angle, with the apical portion of the costal margin, and but slightly convex) leads us to presume that the apex was rather pointed, though not falciform.

The neuration of the same wing (Pl. II, fig. 7) is very similar to that of Mylothris.[1] The costal nervure terminates at about five-sevenths the distance from the base of the costal margin to its tip; the subcostal nervure emits two branches before the cell, the second probably close to the apex of the cell, the limits of which are not given in the drawing prepared for me, but which could probably be made out by a sufficiently careful examination of the original; a third superior nervule is emitted from the subcostal nervure at less than half the distance from the origin of the second to the outer border, and the emission of the inferior nervule, if it could be traced, would mark the termination of the cell; the median nervure is of course three-branched and scarcely curves upward at all to meet the subcostal.

[1] Compare, in this respect, Butler's Revision of the Pierinæ, Cist. Ent., I, iii, pl. i, fig. 8; or Trimen, Rhop. Afr. Austr., Pl. ii, fig. 2.

The design of the upper surface of the fore wing (Pl. II, fig. 17) is simple, consisting only of a broad marginal pale band on a dark ground, enclosing small dark spots in the middle of the interspaces.

This fossil was placed by Heer among the Nymphales, and referred, like the preceding, to Vanessa. Heer lays stress on the non-closure of the cell, but it appears questionable whether this is not simply the result of the defective preservation of the fossil. Edwards has since referred it to Argynnis, on account of the general aspect of its markings, and Butler, on the same ground, to Junonia. But the new drawing of the fossil obtained for me through the kindness of my friend Herr Brunner von Wattenwyl, and by him carefully compared with the original, leave little doubt that it is a Pierid, and belongs in the neighborhood of such genera as Mylothris and Hebomoia. The latter genus it closely resembles in the form of the wings. Further comparisons are presented under the species.

MYLOTHRITES PLUTO (Heer) Scudder.

Plate II, figs. 2, 7, 17 (15?).

Vanessa Pluto Heer, Insekt. Tert. Œning., ii, 179–82, Taf. 14, fig. 4, 5 (?) (1849); Ib., Nouv. Mem. Soc. Helv., xi, 179–82, Tab. 14, figs. 4, 5 (?) (1850); Gieb., Deutschl. Petref. 644 (1852); Ib., Faun. der Vorw., 186–7 (1856); Pict., Traite de Palæont., ii, 393, pl. 40, fig. 21 (1854); Lyell, Elem. Geol., 6th Ed., 243, fig. 179 (1865).

Argynnis Pluto Edw., Butt. N. Amer., i, Argynnis I, fig. (1868); Kirb., Syn. Cat. Diurn. Lep., 155 (1871).

Junonia? Pluto Butl., Lep. Exot., 127-28, pl. 48, fig. 7 (1873); Ib., Geol. Mag., x, 3–4, pl. 1, fig. 7 (1873).

Heer's description of this insect is as follows:[1]—

Alis griseo-nigris, anterioribus margine posteriore ocellis sex pallidis.

Länge des Vorderflügels wahrscheinlich 15 Lin; er ist erhalten bis zu 14¼ Lin; grösste Breite 8¾ Lin.

Radoboj. Ein ausgezeichnet schönes Exemplar in dem k. k. Hofkabinet zu Wien; leider fehlt aber der Kopf, der Hinterleib, der grösste Theil der Hinterflügel und die Spitze der Vorderflügel [Pl. II, fig. 2].

Der Brustkasten ist länglich oval, in der Mitte zwei Linien dick, an der Oberseite von ein paar Streifen durchzogen. Der Oberflügel ist am Grunde schmal, nach dem Hinterrande hin aber stark verbreitert und erreicht daselbst seine grösste Breite. Die Aussenrandlinie (v. marginalis) ist sehr stark gebogen, und zwar bildet sie vom Grunde zur Spitze eine regelmässige, starke Bogenlinie.

[1] Insekt. Tert. Œning., II, 179–82.

Die Schulterader ist am Grunde stark $\frac{3}{4}$ Lin. vom Rande abstehend und läuft ausserhalb der Flügelmitte in denselben; die vena externo-media ist ihr sehr genähert und nur mit Mühe zu unterscheiden, sie mündet noch näher flügelspitzwarts in die Randader. Sie sendet zunächst einen einfachen Ast ab, der mit dem Hauptstamm parallel läuft, ihm sehr genähert ist und noch näher der Flügelspitze in die Randader mündet; der zweite Ast spaltet sich bald wieder in zwei Aeste, von denen der äussere vor der Flügelspitze in die Randader auslauft, der innere theilt sich nochmals in zwei Gabeläste, welche ohne Zweifel innerhalb der Flügelspitze ausmünden; ganz nahe, wo der zweite Hauptast der vena externo-media entspringt, läuft der dritte aus, der einfach und nach dem Hinterrande geht; auf diesen folgt ein vierter Ast, dessen Insertion aber nicht zu sehen; es scheint, dass er auf der Flügelfläche entspringe.—Die vena interno-media ist ebenfalls stark ausgesprochen; sie sendet nach Innen zwei starke, aber einfach bleibende Aeste aus, so dass sie im Ganzen in drei parallelen Adern in den Hinterrand einmündet. Das Mittelfeld ist verhältnissmässig ziemlich klein und nicht geschlossen, indem kein Querast die beiden Mitteladern verbindet. Die vena analis ist einfach und läuft nahe dem Nahtrande herunter. In den Feldern zwischen je zwei Längsrippen sieht man eine schwache Längslinie, welche vom Flügelrande dis zum Augenpunkt lauft; sie stellt eine schwache Furche oder Falte dar, die dort im Flügel sich befunden hat. Der Hinterrand ist leider nicht ganz erhalten, namentlich fehlt die Flügelspitze, de- [180] ren Form zur Bestimmung der Gattung so wichtig wäre; es ist daher nicht zu ermitteln, ob diese ganzrandig oder gezacht war. Der Hinterrand verlauft in einer schwachen Wellenlinie, indem ganz schwache, stumpfe Kerbzähne an der Ausmündung der Längsadern liegen.

Die Farbe des Flügels ist ein dunkles Graubraun; am Grunde und im Randfelde ist er dunkler, welche dunklere Parthie aber allmählig in die hellere verläuft; gegen die Augenflecken zu wird die Farbe wieder dunkler; längs des Randes bemerken wir eine Reihe (nemlich 6) von runden, hellen Flecken und zwar liegt je zwischen zwei Längsadern ein solcher Fleck, welcher das ganze Feld zwischen den Adern ausfüllt. Es reicht dieser helle Fleck nicht bis zum Flügelrande, welcher wieder dunkler graubraun gefärbt ist. In der Mitte jedes Fleckens legt ein schwarzer, runder Punkt; ob dieser noch einen weissen Augenpunkt besessen habe oder nicht, ist nicht mit Sicherheit zu ermitteln, doch ist es wahrscheinlich, indem wenigstens bei zwei dieser Punkte in der Mitte eine kleine, hellere Stelle wahrzunehmen ist. Diese hellen Augenflecken scheinen von keinem schwarzen Ring eingefasst zu sein.

Von den Unterflügeln ist nur der Grund erhalten. Wir sehen da die, bald in zwei Gabeläste sich spaltende, vena analis und die beiden am Grunde ganz genäherten Mitteladern. Die Färburg dieses Flügeltheils ist gleich wie am Oberflügel, und zwar nach dem Grunde zu auch dunkler werdend. . . . . .

Die Bestimmung der Gattung, zu welchem unser Thier gehört, wird sehr dadurch erschwert, dass der Hinterrand nicht ganz erhalten ist. Nach [181] der allgemeinen Form und dem Geäder der Flügel muss er wohl zu den Nymphaliden gehören. Bei den Papilionen, Pieriden, Danaiden und Satyriden ist die Mittelzelle der Flügel durch einen starken Verbindungsast der vena externo- und internomedia geschlossen, wogegen beim fossilen Thiere die Mittelzelle des Oberflügels, und vielleicht auch die des Unterflügels, geöffnet ist, wie diess bei vielen Nymphaliden vorkommt. Von den Pieriden unterscheidet er sich überdiess durch die Art der Varästelung der v. externo-media, indem (um mich der Terminologie von Herrich Schäffer zu bedienen) die 7te und 9te Rippe, vom Nahtrande an gerechnet, aus der sechsten entspringen, und die achte aus der siebenten, während beim fossilen Thiere die 8te und 9te Rippe, wie bei den Nymphaliden, aus der 7ten entspringen. So weist also das Geäder auf einen Nymphaliden. Unter diesen kommen ein paar Gattungen vor (nemlich Apatura und Melitæa) mit offener Mittelzelle der Hinterflügel; allein bei diesen finden sich keine Arten mit Augenflecken, wogegen unter den Vanessen eine Art vorkommt, welche in der Fleckenbildung eine auffallende Aehnlichkeit mit dem fossilen Thiere hat. Zwar ist bei Vanessa die Mittelzelle der Hinterflügel geschlossen, aber durch einen so zarten, feinen Querast, dass dieser sich leicht verwischen konnte. Jene dem fossilen Thiere nahe verwandte Art der Lebenwelt ist die Vanessa Hedonia L. F. Cramer de Uetlandsche Kapellen T. II, Taf. 69, C. D. und T. VIII, Taf. 374, E. F. Es hat diese genau die Grösse des fossilen Thieres, der Aussenrand bildet ebenfalls eine starke Bogenlinie; die Oberflügel sind grauschwarz und haben am Hinterrande eine Reihe von 6 Augenflecken; es sind diese roth und mit einem schwarzen Punkt in der Mitte versehen; dieser schwarze Punkt umfasst einen kleinen weissen Punkt. In der Vertheilung und Stellung dieser Flecken stimmt Pluto ganz mit Hedonia überein, nur sind bei letzterer die Flecken kleiner und von einem schwarzen Ring umfasst; ferner sind sie etwas weiter vom Rande abstehend. Die Vanessa Hedonia kommt auf Ceylon, Amboina, Java und den Phillippinen vor, hat also im tropischen Asien eine weite Verbreitung.

Von Schmetterlingen mit ähnlicher Färbung können noch in Betracht kommen: die Argynnis Diana Cramer II, p. 4, t. 98, D. E. Say. Americ. En- [182] tom. 17, welche im südlichen Theile der vereinigten Staaten (Neu-Georgien, Westflorida, Arkansas and Missouri) lebt. Es hat dieser Schmetterling eine ähnliche Tracht, ist schwarz und am Hinterrande mit einer Reihe gelber Flecken versehen, welche je zwischen die Längsadern vertheilt sind. Diese gelben Flecken reichen aber bis zum Rande, und ferner hat jeder zwei schwarze Punkte. Auch ist die A. Diana bedeutend grösser. In Grösse und Färbung stimmt daher das fossile Thier mehr mit der Hedonia überein, als mit der Diana, doch kann mit voller Sicherheit erst darüber entschieden werden, wenn enimal ein Exemplar mit vollständig erhalt-

enem Hinterrand gefunden wird; was von diesem erhalten ist, spricht aber auch mehr für die Hedonia als die Diana.

Edwards, in his beautiful work on American Butterflies, refers to this insect in his description of *Argynnis Diana*[1] and reproduces, from Lyell's Elements of Geology, Heer's figure of the insect. He remarks: "It is called Vanessa Pluto in the text, but is plainly an Argynnis."

Butler, when cataloguing the same insect, remarks:[2]—

It is quite possible, as Mr. Edwards suggests, that the so-called "*Vanessa Pluto*" may be the ancestor of *P. Diana*, though in the narrower banding of its wings, with but one row of submarginal spots, it more nearly resembles some of the East Indian forms of *Junonia Hedonia:* the two genera to which these species belong agree in many respects, and are perhaps nearly allied.

Later, he figures the fossil and refers it doubtfully to Junonia, appending the following remarks:[3]—

I have noticed this species at p. 109 of my catalogue of Fabrician Diurnal Lepidoptera; Mr. W. H. Edwards of W. Virginia having decided in his Butterflies of N. America that it is unquestionably an *Argynnis* allied to *A. Diana*, notwithstanding the important discrepancies which Heer points out [128]. That it may bear some distant relationship to *A. Diana* is quite possible, but that it is "plainly an *Argynnis*" is quite another thing; to my mind it is plainly a *Vanessid*, probably a *Junonia* near to *J. Hedonia*, and I think some points in Heer's description (of which Mr. Edwards takes no notice) are very important, as evidencing its near relationship to *J. Hedonia* rather than to *A. Diana* [here he quotes Heer's description of the submarginal spots].

The ocelli are well shown in Heer's figure, but in the woodcuts by Lyell and Edwards, which have in other respects been made much darker than the original, the indication of the lower edge of the ocelli has been omitted altogether, and, consequently, the resemblance to the species of *Junonia* is rendered less evident. I think it just possible, from the great resemblance which *V. Attavina* of Heer bears to the under surface of *J. Hedonia*, that it is the reverse of *J. Pluto*.

This species is very simple in its markings (Pl. II, fig. 17), the whole upper surface, excepting a broad space next the outer border of the fore wings (the equivalent part of the hind wings is not preserved) being of an uniform dusky tint; a broad belt of a lighter shade margins the (fore) wings, growing less

[1] Butt. N. Amer., i, Argynnis, I.
[2] Cat. Fabr. Lep., 109.
[3] Lep. Exot., i, xv, 127-28, Pl. 48, fig. 7; Geol. Mag., x, 3-4, Pl. 1, fig. 7.

distinct from the darker base above the next to the lowest subcostal nervule; this belt darkens toward the outer border, especially in slight dusky fleckings along the nervures and down the middle of the interspaces; the latter streaks reach small, round, blackish spots about one-quarter the width of the interspaces, in the middle of the basal two-thirds of their lighter parts. Heer represents them too far from the outer margin of the wing, and as often crowned above with a dark semicircular line, which is not at all indicated in the drawing made for me; these spots are found in all the interspaces below the outermost superior subcostal nervule, but they are very indistinct and minute above, faint below and only distinct and as large as stated in the three interspaces next above the lowest median nervule. The light belt is two interspaces wide in the upper median interspace, but widens a little above this and is separated from the darker base by a vague and very slightly crenate line (less crenate than in the representation by Heer), which approaches the outer margin at the nervures and to a slightly greater extent in the lower part of each interspace than in the upper.

Pierids with so dark a coloring as appears in this fossil are not unknown, particularly in the genera Archonias and Pereute; compare for example the figure given in Doubleday and Hewitson's Genera of Diurnal Lepidoptera, Pl. V, fig. 2. And that markings of this character are not unknown, compare some species of Ixias, Hebomoia and allied genera; if the colors of *Hebomoia Leucippe*, as given by Doubleday and Hewitson, were reversed, the resemblance to Pluto would be rather close; and while light spots in a dark border are the rule in this subfamily, dark spots on a light ground are not unknown, and the reversal of tints is a not uncommon occurrence in nearly related Lepidoptera.

A second fossil, which I have been unable to see or to have redrawn, is given by Heer as probably representing the under surface of the same insect. His remarks are as follows:[1]—

Hierher rechne ich auch ein Stück eines Unterflügels aus der Grätzer Sammlung, das bei Taf. XIV, Fig. 5 [Pl. II, fig. 15], dargestellt ist. Die Hauptadern treten an diesem Flügelstücke alle hervor. Die beiden Mitteladern schliessen ein nicht sehr grosses Mittelfeld ein; ob dieses durch einen Verbindungsast zwischen

[1] Insekt. Tert. Œning, II, 180.

den beiden Mitteladern geschlossen ist oder nicht, war mir nicht möglich zu ermitteln; bei guter Beleuchtung glaubte ich dort einen schwachen Quereindruck zu sehen, der als Verbindungsast zu deuten wäre; jedenfalls wäre derselbe aber äusserst zart, viel zarter als die übrigen deutlichen Adern. Die äussere Mittelader sendet 4 Aeste aus, der erste entspringt nahe der Flügelbasis und läuft nach dem Aussenrande, die drei folgenden entspringen näher flügelspitzwärts. Die v. interno-media zerspaltet sich in 3 Aeste, ganz so wie die des Oberflügels, welche auch in gleicher Weise verlaufen. Alle 3 Aeste sind fast gleich weit von einander entfernt und entspringen nicht von einem Punkt. Die vena analis zerspaltet sich bald nach ihrem Ursprung in zwei Gabeläste, welche nach aussen laufen. Die Farbe des Flügels ist ein helles Graubraun.

As far as the neuration is concerned (excepting that of the costal nervure, which is certainly incorrectly rendered, and does not accord with the description) it agrees sufficiently with the general neuration of Mylothris[1] to suppose it may belong to the allied genus Mylothrites, but that it can belong to *M. Pluto* is exceedingly improbable, as one may judge by tracing the probable extent of the broken hind wing, and placing the tracing in juxtaposition with the fore wing of Pluto, as in the accompanying woodcut (fig. 1); for it must be remembered that in all the genera of this subfamily, the cell extends at least to the middle of the wing; the hind wing of *M. Pluto* must, therefore, have certainly been fully one-sixth longer than the wing conjectured to belong to it; so great a difference is at least unusual among individuals of the same species in this group; moreover, the neuration is not quite what we should expect, although the appearance of veins on the drawing we have reproduced must be in part due to extraneous causes; we will, therefore, make no attempt to decipher the present condition of the fossil, trusting that some of the Austrian lepidopterists will give the subject early attention.

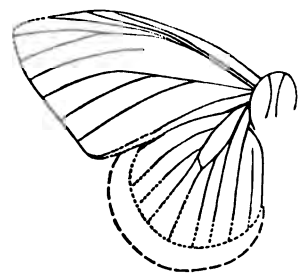


Fig. 1.

Fig. 1. The dotted outer border of the hind wing represents the probable limit of the Gratz fossil. The broken outer border indicates the probable size of the hind wing of *Mylothrites Pluto*.

A study of the original description and illustration of the front wing of this butterfly leads me to the conclusion that the description of the neuration of

[1] Compare the illustrations referred to in the note on page 44.

the fossil was drawn up from the illustration and not from the fossil itself. Both agree in the points in which my drawing (Pl. II, fig. 7) differs from them; and since in these very points they will not harmonize with the neuration of any living Lepidoptera, while the drawing I present agrees as well as could be desired with certain of them, I am forced to believe the original drawing published by Heer, and the accompanying description, presumably founded upon it, to be incorrect. I am acquainted with but very few living butterflies[1] in which a nervule is emitted from the inferior side of the subcostal nervure nearer the base of the wing than any of the superior nervules of the same vein; this is the manner in which the neuration of this butterfly is represented in Heer's plate and in his description, if read carefully in connection with the plate; although he does not tell us on which side of his *zweite Hauptast* his *dritte Hauptast* originates.

The description given by Heer of the markings of the fore wing is more complete than I have been able to offer from an inspection of drawings alone; it differs, too, in one somewhat important point, in that what I have called a broad lighter belt with blackish dots in each interspace, he has described as a series of pale circular spots as broad as the interspaces, each containing a blackish pupil. A reëxamination of the fossil upon this point is desirable; the only indication of such circular pale spots in my drawing is the curved boundary in each interspace between the darker and lighter portions.

Tertiaries of Radoboj, Croatia. Fore wing, Hof-Mineralien Kabinet, Vienna. Hind wing, Museum of Gratz, Austria.

COLIATES Scudder.

The fore wing (Pl. II, fig. 5) is slightly more than twice as long as broad; the costal border is straight for fully two-thirds its length, and then curves gradually and slightly downward, the apex rounded off; the outer margin has a nearly regular and slight convexity, but is nearly straight in the middle half; the lower outer angle is rounded and the inner margin slightly convex. The costal nervure

[1] These, it is true, are Dareal, but aberrant forms, like Leptidia, etc.

scarcely reaches the middle of the costal border; the discoidal cell is but little more than half the length of the wing; the subcostal nervure has but two superior branches, although the outer is not only itself forked, but its upper fork is branched at the extreme tip of the wing; the first superior nervule is emitted at some distance previous to the tip of the cell, or opposite the base of the first median nervure; it terminates in the middle of the outer half of the costal margin, and the forked branch of the outer superior nervule supports the extreme apex of the wing; the inferior subcostal nervule arises midway between the bases of the two superior nervules, and terminates about one-third way down the outer border; the vein closing the cell strikes it near the base and has an inward convexity, meeting the upper median nervule farther from its origin; the first median nervule originates at some distance beyond the middle of the cell.

In the form of the wing and its neuration this fossil group is more nearly allied to Delias (Pl. II, fig. 4) than to any other genus I have been able to examine. It is plain at first glance that it must be placed in the vicinity of Delias, Thyca, Prioneris and similar East Indian Fugacia, in which there are but two superior subcostal nervules, and in which the outer of these is forked; but I have met with no instance among these in which one of these forks is itself branched; and this insect differs notably from them all in the elongate form of the wing, the remarkably straight costa[1] and the shorter discoidal cell; and from all Pierids in the shortness of its costal nervure and the basal extension of the first superior subcostal nervule; this latter nervure always originates, in every living type I have examined, at or beyond a point opposite the middle of the space between the bases of the first and second median nervules.

COLIATES PROSERPINA Scudder.

Plate II, fig. 5.

The fossil to which I have given this name is exceedingly obscure, having no color whatever distinct from the stone in which it is imbedded; this is of a chalky gray color. I have seen both impression and reverse, the latter a little in relief.

[1] See, however, the American genus Leodonta.

The fossil consists of both anterior wings, one beneath and slightly in advance of the other, thus complicating very greatly the study of the already indistinct neuration; in addition to this the wings are crumpled and additional longitudinal lines are present, scarcely distinguishable from the longitudinal nervures. On this account it should be stated that there may be some doubt about the exact position of the lowest three branchlets of the subcostal nervure. The stone has been broken next the edge of the wing, and its form can thus be traced where the real border is wanting, although again the drawing presented may be slightly inaccurate next the inner margin; but the probabilities are great that it is correct throughout. The spots which are represented on our plate in the middle of the lower median, subcosto-median and lower subcostal interspaces, are only irregularities of surface on the stone, but as they appear in regular position are not improbably dark spots, upon a light ground. A few points for the insertion of the scales can be detected near the apex of the wings, ·075$^{mm.}$ apart. The neuration of the fossil agrees better with that of *Delias Pasithoe* than with that of any other butterfly I have examined. Length of wing, 21$^{mm.}$; greatest breadth, 9$^{mm.}$.

Tertiaries of Aix, Provence, France. Collection of Count de Saporta.

PAPILIONIDÆ—DANAI—VORACIA.

PONTIA Fabricius.

Pierites Heer, Insekt. Tert. Œning., ii, 182; Ib., Nouv. Mem. Soc. Helv., xi, 182; Gieb., Faun. der Vorw., ii, 187.

Fore wings fully three-quarters as long again as broad, the costal margin slightly convex at the basal and apical fifth, scarcely bent at an angle with the nearly straight middle portion, the outer angle abrupt but softened. Outer margin nearly straight and inclined at an angle of forty-five degrees with the middle portion of the costal border, above the middle subcostal nervule receding slightly in a gentle curve. Inner margin straight, the outer angle well rounded. Costal nervure terminating a little beyond the middle of the margin. Subcostal nervure with three

superior branches; the first arising shortly before the middle of the outer half of the cell, a little nearer the apex of the cell in the female than in the male; the second arising scarcely (male), or a very little (female), beyond the tip of the cell; the third emitted at about two-fifths the distance from the apex of the cell to the outer margin, forked at the extreme tip in the male. Cell half as long as the wing and nearly four times as long as broad.

The butterflies are scarcely larger than those of the genus Pieris, but have more pointed fore wings; like them they are white, but extensively spotted with deep brown; the fore wings have a broad bar at the tip of the cell, and midway between this and the outer border a widely interrupted transverse series of similar but smaller spots; the outer border, especially the upper half, is also more or less distinctly margined with triangular, frequently confluent spots seated in the interspaces; these occur more often in the female than in the male.

The characters given above are drawn wholly from recent species of the genus.

PONTIA FREYERI (Heer) SCUDDER.

Plate II, figs. 16, 18.

Pierites Freyeri HEER, Insekt. Tert. Œning., ii, 182–83, Taf. 14, fig. 6 (1849); IB., Nouv. Mem. Soc. Helv., xi, 182–83, Taf. 14, fig. 6 (1850); GIEB., Deutschl. Petref., 644 (1852); IB., Faun. der Vorw., ii, 187 (1856); KIRB., Syn. Cat. Diurn. Lep., 509 (1871).

The original description of this insect we owe to Heer; it is as follows:[1]

Alis anterioribus lividis, margine maculisque duabus nigris.

Länge des Vorderflügels $9\frac{3}{4}$ Lin., Breite $5\frac{1}{2}$ Lin.

Radoboi. Ein einzelner Vorderflügel, dessen Spitze und theilweise auch Hinterrand aber zerstört ist, in der k. k. montanistischen Sammlung zu Wien. [Pl. II, fig. 16.]

Das Geäder ist nicht in seinem Verlauf zu ermitteln und da auch der Umriss des Flügels nicht vollständig vorliegt, ist die Gattung nicht mit Sicherheit zu ermitteln. In Form und Farbe scheint er am meisten mit manchen Pieriden, namentlich Pieris Daplidice, zu stimmen, wofür auch das dünne Schuppenkleid, das er gehabt zu haben scheint, angeführt werden kann, wogegen die allerdings stumpfen Zacken am Hinterrand eine abweichende Bildung zeigen.

[1] Insekt. Tert. Œning., ii, 182–3.

Der Flügel ist am Grunde stark verschmälert, nach dem Hinterrande zu stark verbreitert; der Hinterrand ist stumpf gekerbt; in die Bucht der Kerbe läuft eine Längsfalte, in die Mitte derselben eine Ader aus, die man aber nicht bis zur Insertionsstelle verfolgen kann; die äussere Flügelspitze fehlt; ebenso ein Stück des Hinterrandes an der [183] Nahtseite. Von den Adern kann man nur die einfache v. analis in ihrer ganzen Länge verfolgen; sie ist dem Nahtrande sehr genähert. Die Farbe des Flügels ist hell gelbbraun und war im Leben wohl weiss oder gelblich. Der Hinterrand ist von der Mitte an bis zum Aussenrand schwarz, und zwar wird diese dunkle Parthie auswärts breiter; ungefähr in der Flügelmitte geht vom Aussenrand ein viereckiger, dunkler Fleck aus, welcher dieselbe Grösse, Form und Stellung hat, wie der schwarze Fleck bei Pieris Daplidice; ein zweiter kleinerer, rundlicher Fleck liegt näher dem Hinter- und Nahtrande und entspricht dem, an derselben Stelle liegenden, Flecken der Unterseite von Pieris Daplidice.— Am Flügelgrunde bemerkt man den Schenkel und Schiene eines dünnen Beines, das wohl diesem Thiere angehört hat.

This insect evidently belongs to the genus Pontia, judging from the disposition of the markings of the upper surface of the fore wings (Pl. II, fig. 18); this is the only thing we have here to guide us, although the drawing made for us in Vienna seems to show that with great pains the neuration of at least a part of the apex might be traced and lead to more positive determination. The fossil species seems best comparable with *P. Protodice* (Pl. II, fig. 12) of N. America, although, as suggested by Heer, most nearly resembling *P. Daplidice*, of European species. The dark spot at the apex of the cell appears to cover a larger area than in *P. Protodice*, extending with equal breadth almost to the costal margin, and also covering a considerable space at the base of the subcosto-median interspace, equal indeed to the entire width of the portion of the spot within the cell. The region below this spot, next the base of the lower median interspace, is also rather faintly suffused with griseous tints. The precise extent of the subcostal spots midway between the cell and the apex cannot be determined, owing to the imperfect state of the fossil; but they evidently form a connected series as much larger than the similar spots in *P. Protodice* as the cellular spot, and extend from the costal margin to the lowest subcostal nervures, expanding considerably baseward in the upper half of their course. There is no spot in the upper median interspace, as in *P. Protodice*, but, instead, a precisely similar one in the middle of the apical

three-fifths of the lower median interspace, where it does not occur in *P. Protodice;* and this affords the principal ground for supposing the insect to be generically distinct from Pontia, no distinctive premarginal spot occurring in this interspace in any species of Pontia which we have seen. The dusky premarginal fleckings of the nervures terminating on the outer border, often enlarging into distinct spots, which are so usual in Pontia, especially in the upper half of the wing, are also absent from the fossil species; but in their place the whole outer margin appears to be almost uniformly, though not heavily, griseous, a little more distinctly so in the upper than in the lower half of the wing. The spot just beyond the middle of the medio-submedian interspace, distinct in *P. Protodice*, but deepest in shade on the lower half of the interspace, and in other species sometimes wholly confined to it, is seen in the fossil species, but is far less distinct, confined to the lower half and situated exactly in the middle. There are indications also of dark markings following the basal third of the submedian nervure; and apparently the basal half of the costal edge, as far as the costal nervure, is darker than any part of the wing, excepting in a sudden and rather broad, distinct break in its middle. This darker portion is considered by Heer as the femur of one of the legs, superimposed upon the base of the wing; perhaps, however, this is due to an accidental folding of the wing at this point, which seems the more probable, because if we suppose this darker portion to be turned back, the curve of the costal border would approximate much more closely to its condition in *P. Protodice;* while its present form is much straighter, exhibiting only a very slight and regular convexity. As far as can be judged from the fragment, the form of the other parts of the wing coincides with that of *P. Protodice.*

As in all species of Pontia there is a slight wrinkling of the membrane in the interspaces, forming slight channels running from the outer border inward, nearly to the depth of two interspaces, indicated in the fossil by dark lines as heavy as the nervures, and caused by their filling with sedimentary material. The extreme length of the part of the wing preserved is $24^{mm.}$ and the greatest width $22.5^{mm.}$.

The markings lead one to conjecture that the individual was a male.

PAPILIONIDÆ—PAPILIONIDES—PARNASSII.

THAITES Heer, MS.

Body rather robust (Pl. III, figs. 9 and 10). Vertex of head large, broad, convex. Eyes pretty large, short ovate, their longer diameter vertical. Palpi (Pl. III, fig. 7) slender, resembling those of Thais, but rather longer, extending far beyond the eye, rather thinly clothed with hairs. Antennæ (Pl. III, fig. 8) resembling those of Sericinus more than those of Thais, being about half as long as the body, slender and equal on the basal three-fifths, gradually expanding beyond into a club, which is more than twice as broad as the stem, and stoutest just before the well rounded, slightly upturned tip; in the middle of the antennæ the joints are half as long again as broad, broader than long at the base of the club, and three or four times as broad as long in the middle of the club and beyond; on the apical half of the club, and perhaps a little further, the joints of the club are furnished with a double row of minute shallow pits, such as are seen in Eurymus. The tongue was at least as long as the thorax.

The thorax is well arched and pretty stout; the paraptera (Pl. III, fig. 6) are a little more than twice as long as broad, their outer edge nearly straight, the posterior extremity broad and well rounded. The legs are not well enough preserved to state anything concerning them with certainty, but the middle (?) pair are probably of the length of the antennæ.

The fore wings (Pl. III, fig. 3) are only a little more than half as long again as broad, the greatest breadth beyond the middle; the costal border is pretty regularly and not greatly arched throughout; the outer margin is more strongly arched but with a similar regularity, and the general direction of its upper half is at right angles to the outer third of the costal border, the apex scarcely rounded off; the inner border is nearly straight. The proportions of the hind wing, as to length and breadth, are nearly the same as those of the fore wings, making it unusually long and narrow, as in Thais (Pl. III, fig. 4), and also, as there, nearly as broad toward the base as at tip. The costal border is rather strongly convex next the base of the wing, but beyond is nearly straight, sloping apically so as to make a

uniform curve with the outer border, which is almost entire as in Parnassius (Pl. III, fig. 5), rather than as in Thais (Pl. III, fig. 4), strongly arched, especially near the last median nervule, and angulated below where it meets with the regularly and broadly concave inner margin.

In the neuration of the fore wings (Pl. III, fig. 1) this genus is peculiar for the shortness of its cell, which is less than half as long as the wing, and is broadest in the middle of its distal half, beyond which it narrows rather rapidly. The costal nervure terminates a little before the middle of the outer two-thirds of the costal border. The subcostal nervure emits two superior branches before the cell; the first is thrown off near the middle of the outer half of the cell and terminates as far beyond the tip of the costal nervure as it is beyond the middle of the costal border; beyond the emission of the first superior nervule the subcostal nervure curves downward away from the costal nervure, with which it had hitherto been parallel, and throws off the second superior nervule shortly before the apex of the cell; this nervule terminates exactly at the apex of the wing, but, just before the tip, divides, sending a short branch to the outer border; about two-fifths of the distance from the tip of the cell to the outer border, the subcostal nervure divides into two branches which reach the outer border near the middle of its upper half; the inferior subcostal nervule leaves the nervure nearly at right angles, but almost immediately turns and runs subparallel to it and its lower ultimate branch. The median nervure throws off its first nervule a little beyond the middle of the cell; its second midway between this and the base of the fourth, and the third midway between its two neighbors; beyond the emission of the second nervule the nervure bends upward, and still more on throwing off the subsequent one; the first two nervules are straight, the upper two arched, and the base of the last is united to the short basal fragment of the inferior subcostal nervule by a curving vein opening outward, whose general course is nearly at right angles to the costal border.

In the hind wing the relation of the cell to the length of the wing is as in the front pair; it is broadest at the first divarications of the bordering nervures and narrows rapidly beyond. The first branches of the subcostal and median nervures are emitted near the middle of the distal half of the cell, and that of the subcostal

is a nearly straight continuation of the basal portion of the nervure; the outer subcostal and median nervules are twice as close at base as any of the others, and the middle nervules divide the space between the first and third; the submedian nervure is parallel to, and scarcely removed from, the inner border.

In the pattern of their markings (Pl. III, fig. 3) the wings of Thaites are rather simple. The fore wing is provided with four nearly equidistant, nearly straight, transverse, pale stripes, depending at about right angles from the subcostal nervure, unequal in length and width, the third from the base situated in the middle of the wing; and also with a submarginal curving row of moderately large, transversely ovate spots, one in each interspace opening on the outer border, excepting the subcosto-median and medio-submedian interspaces, all ranged in a series curving more strongly than the outer border. The hind wing is nearly uniform on the basal half, but beyond is crossed by transverse, curving, dark, cloudy bands, broadening on the nervures and enclosing between them roundish or transversely ovate pale spots.

The abdomen is stout, half as long as the hind wings, well arched, and the terminal segment (of the female?) half as long as broad, the segments provided with a latero-dorsal and pleural row of very small, vertically ovate, pale spots.

This genus differs from Thais (Pl. III, figs. 2, 4) and the other genera allied to the swallow-tails in about the same degree as they do among themselves. It is closely allied to Thais in most particulars; the antennæ resemble those of Thais, more than they do those of other genera, if we except only Sericinus; in the form of the wings it lies midway between Thais and Archon; as to neuration the discoidal cell of the fore wings has the form seen in Sericinus, being broadest apically, while in Parnassius (Pl. III, fig. 5), Thais and Eurycus it is largest in the middle; but it is shorter than half the length of the wing, while in Sericinus, as in all the other genera, it is considerably more than half the length of the wing; the tip of the cell is limited above, in most of these genera, by the vein closing the cell; that is, the inferior subcostal nervule originates beyond the tip of the cell; but in Thais it originates at the tip of the cell, while in Thaites the cell is limited by the inferior subcostal nervule and the vein closing the cell originates from it; in other particulars of its neuration it resembles the tailed Sericinus.

In design (Pl. III, fig. 3) Thaites recalls none of the recent genera very closely. In the fore wings it approaches Thais (Pl. III, fig. 4) rather than the others, and in the hind wings some species of Parnassius (Pl. III, fig. 5). It has none of the eccentric spots of Parnassius and a darker ground than any of the modern types. It is wholly unprovided with the strongly marked crescentic spots of Thais, but in the position, form and arrangement of the principal markings rather recalls Archon. Excepting Eurycus and some species of Thais, no modern genera resemble Thaites in the extension of a distinctive pattern upon the hind wings to or nearly to the extremity of the cell. Whether any of the markings were accompanied by the brilliant spots often seen in Thais, Archon and Parnassius cannot be determined, but we may presume that they were not, since in these genera the markings are dark upon a lighter ground, while in Thaites they are light upon a dark ground,—a combination found among the Papilonid genera, only in some of the swallow tails.

In the markings of the abdomen, I do not know that we find anything parallel to Thaites among the Parnassians, but among the neighboring Equites there are similar examples of rows of small light spots on a dark ground. I have not been able, however, to examine this point carefully.

THAITES RUMINIANA HEER MS.

Plate III, figs. 1, 3, 6-10.

Thaites Ruminiana HEER, Climat pays tert., trad. Gaudin, 205 (1861) [absq. descr.]; Sap., Ann. Sc. Nat. [5], Bot., xv, 343 (1872) [ibid.].

The wings were evidently dark with light markings. On the fore wings the first transverse stripe (Pl. III, fig. 3) extends from the subcostal nervure, midway between its first divarication and the base of the wing, almost to the middle of the basal two-thirds of the inner border; it is slender, nearly equal and straight, the portion within the cell about four times as long as broad; the second transverse band is the largest, and lies midway between the first and the third, parallel to them, reaching from the subcostal nervure almost to the inner border; it is straight and equal, and the portion within the cell (which is half of the whole, although

traversing the cell at its broadest part) is three times as long as broad; the third transverse bar is in the middle of the wing, smaller than the first and equally slender, extending from the subcostal nervure, just beyond the tip of the cell, almost to the upper median nervule; it is equal and straight excepting above, where it curves inward following the border of the cell; the outermost is broader and more irregular, depending from the first superior subcostal nervule and extending nearly to the upper median nervule, so that its exterior border just strikes the subcostal nervure at its divarication far beyond the cell; the inner margin is straight and the spot thus forms a transverse bar, straight and equal above the subcostal nervure, but with the outer border sloping away so that the lower extremity is twice as broad as the upper. The submarginal series of spots are of nearly equal size, the uppermost largest, the next two smallest; each set of three forms a nearly straight line, but all together they follow a strong curve which approaches close to the border in the lowest subcostal interspace, being separated from it by but its own width; above this they recede rapidly from the border, the outer edge of the innermost being next the fork of the second superior subcostal nervule; but below, the spots are parallel to the outer border and separated by about an interspace's width from it; the upper spots are transversely broad ovate; the lower transversely subquadrate; apparently the fringe is exceedingly short and concolorous as in Parnassius.

The basal parts of the hind wing are almost uniformly dark, excepting that there is a paler suffusion in the outer part of the cell; beyond, the wing is clouded with darker, transverse, strongly curving, powdery stripes; the most conspicuous of these is one which crosses the wing a little outside the middle of the portion beyond the cell; it takes its rise in a darker spot, which borders the wing just above the tip of the upper subcostal nervure, and runs in a nearly straight line, widening as it goes, to the lowest subcostal nervule, where it reaches its greatest width, and scarcely narrowing curves around to the inner border a little before its tip; on the nervules it reaches further baseward and borderward. Between this belt and another similar but much less conspicuous band, half way between it and the tip of the cell, are enclosed circular pale spots, one occupying the entire width of each interspace below the middle subcostal nervule and a portion of the one

above it; following the principal dark band are two alternating sets of dark and light, narrow, inconspicuous, transverse stripes, more or less confused in the middle of the wing, the dark bands broadening and deepening at the nervures, breaking the paler bands to a greater or less extent into broad transverse spots; the fringe appears to be as on the fore wings. Judging from the form of the last abdominal segment, and the great size of the abdomen, this specimen was probably a female. Length of fore wing, 25$^{mm.}$; breadth of the same, 14·3$^{mm.}$; length of antennæ, about 6$^{mm.}$; breadth of antennæ in middle of stem, ·2$^{mm.}$; breadth of antennæ toward tip of club, ·5$^{mm.}$.

Tertiaries of Aix. Collection of Professor Heer; Zurich, Switzerland.

URBICOLÆ—HESPERIDES.

THANATITES Scudder.

Very much of the general appearance of Thanaos Boisd. (Pl. III, fig. 2) but with somewhat differently formed wings and markings which will not accord with those of the latter genus, although the two genera are certainly nearly allied.

The body (Pl. III, fig. 12) is fully as stout as in Thanaos (Pl. III, fig. 11), the tongue at least as long as the thorax, the eyes ovate and larger than in Thanaos, and the palpi with the terminal joint proportionally larger, which is an unusual feature in the Urbicolæ. The legs are apparently short, the wings ample. The costal margin of the fore wings is nearly straight, being scarcely arched on the apical half, the upper half of outer border as in Thanaos, the rest not preserved; the costal fold of the male is narrow and extends a very little beyond the middle of the costal border, while in Thanaos it reaches considerably further; the hind wings have the general shape of Thanaos, but the upper outer angle is much more produced, and the base of the costal border is arched only to the degree that the apex is, and the portion between them is but slightly convex; the outer border is almost precisely as in Thanaos and the inner border is, doubtless, folded in the fossil so as to conceal its true character. Very little of the neuration can be determined, and what can be made out is comparatively unimportant and agrees with the neuration of Thanaos; the third superior subcostal nervule strikes the

apex of the fore wing as in that genus. As to the markings, the agreement with Thanaos is less striking, although the pattern resembles that of Thanaos more closely than it does that of any other genus. In the fore wings the spot in the cell of Thanaos is wanting in the fossil, but in its stead there is a costal spot at the extremity of the costal fold; the subapical spots of Thanaos depending from the costa are distinctly repeated in Thanatites, and in addition there is a submarginal series of small round spots of which the upper two, in the uppermost interspaces opening on the outer border, are the only ones visible on the fossil by its mode of preservation. On the under surface of the hind wings of Thanatites, there is a regular submarginal series of equal, rather small, round spots, one in each interspace, placed between the location of the marginal and submarginal spots which occur in Thanaos, often distinctly, occasionally as faint blurred bands, as in *T. Juvenalis* (Pl. III, fig. 11); the inner of these two series in Thanaos, which corresponds best to the submarginal series of Thanatites, is irregular instead of parallel to the border, being always bent inward opposite the cell. Instead of the spot, placed in the costo-subcostal interspace of Thanaos near the middle of the wing, and seen distinctly in *T. Juvenalis*, there are two spots, which, with a third near the base of the wing above the costal nervure, are placed at equal distances apart and from the costal border; in addition there are two spots, seldom even indicated in Thanaos, near the centre of the wing, the larger of which is near the apex of the cell. These differences alone would suffice to show that the fossil cannot be referred to Thanaos, and, with the other indications we have given, compel us to place it apart, but in the immediate vicinity of this group of Urbicolæ.

THANATITES VETULA (HEYDEN) SCUDDER.

Plate III, figs. 12, 16.

Vanessa vetula HEYD., Palæontographica, viii, 12–13, Taf. I, fig. 10 (1859).
Araschnia vetula KIRB., Syn. Cat. Diurn. Lep. 179 (1871).

The only notice of this insect that has been published is the original figure and description of von Heyden. The figure is reproduced in our Pl. III, fig. 16. The description is as follows:[1]—

[1] Palæontogr. viii, 12–13.

Es scheint diese Art in die Nähe der bei uns lebenden Vanessa Levana zu gehören. Sie ist kleiner als diese, indem der Vorderflügel von seiner Basis bis zur Spitze nur $6\frac{1}{2}'''$ misst. Der Schmetterling liegt auf der rechten Seite, wobei der linke Hinterflügel den linken Vorderflügel völlig bis auf die Spitze und einen Theil des Aussenrandes deckt. Von diesen Flügeln ist daher nur die Unterseite sichtbar. Der rechte Vorderflügel ist mehr vorgeschoben und daher ein grosser Theil seiner Oberseite sichtbar.

Die Flügel sind im Allgemeinen gut erhalten und scheinen am Aussenrande an einigen [13] Stellen schwach ausgerandet gewesen zu seyn. Sie zeigen auf der Grundfarbe grössere, undeutlich schwarze und viele weisse Flecken von verschiedener Grösse. Auf den Vorderflügeln zeichnen sich ein grösserer weisser Flecken, etwa ein Drittel von der Spitze entfernt und nach dem Vorderrande hinzielend, sowie drei weisse Fleckchen aus, die in einer Reihe in der Nähe des Aussenrandes stehen. Auf den Hinterflügeln, etwa ein Drittel vom Aussenrand entfernt, bilden sechs weisse Fleckchen eine Querreihe. Es ist nicht unwahrscheinlich, dass die Grundfarbe der Flügel im Leben braun oder rothbraun war, und man glaubt sogar noch einen schwachen Schimmer von dieser Farbe wahrzunehmen.

Der Kopf ist etwas zerdrückt und zeigt zwei ziemlich lange, zugespitzte, in die Höhe gerichtete Taster, von denen der eine vom Kopf getrennt liegt. Oben am Kopf ist noch ein Auge und unten die in einen Bogen aufgerollte Zunge sichtbar. Die Brust ist undeutlich, der Hinterleib fast ganz durch die Flügel gedeckt, und von den Beinen sind nur Bruchstücke vorhanden.

Dark brown or blackish with light markings. On the upper half of the fore wing (Pl. III, fig. 12), both above and below, the following markings are found: a small quadrate spot on the costal border at the extremity of the costal fold; depending from the costal border between the tips of the second and third superior subcostal nervures a confluent series of spots extending to the cell at right angles to the costal margin, narrowing a little in passing downward; and midway between this and the outer border, in the upper two subcostal interspaces opening on the outer border, a small round spot; probably similar spots belong in some of the interspaces below. On the under surface of the hind wings there is a submarginal series of three small spots along the costa at equal distances apart, the central one near the middle of the costa, and the basal one nearly midway between it and the base of the wing; there is also a larger spot near the tip of the cell and a second smaller one a little below and beyond it; also a submarginal series of spots as large as that in the cell parallel to the outer border, at about an interspace's

distance from it, one in each interspace. Length of fore wing, 14$^{mm.}$; length of hind wing, 13·65$^{mm.}$; extreme breadth of hind wing, 11·25$^{mm.}$.

The single fossil represented by von Heyden under the name of *Vanessa vetula*, is preserved on a greasy, dark brown, thin and exceedingly fragile sheet of "brown coal," and is likely to become so affected by weathering as to be almost or quite indistinguishable in the course of time. Indeed it is excessively obscure at the present time, and no fossil object I have ever studied has proved so difficult to decipher as this. It represents an insect (Pl. III, fig. 12) lying upon its side in a somewhat natural attitude (compare fig. 11), so that one can see the whole of the under surface of the left hind wing, the costal quarter of the under surface of the left fore wing, and a little more than a quarter of the upper surface of the right fore wing, also of the costal area; the thorax and head with the eyes, the denuded palpi, the partially unrolled tongue and fragments of the legs in a confused medley may also be seen, but there is no trace of the antennæ, nor of the right hind wing (nor of the abdomen?). The left hind wing has an immaterial part of its outer border removed, and a small portion of the outer border of the left fore wing is also wanting, but the corresponding portion of the right fore wing is present. The markings can only be made out by extreme care, and a very meagre portion of the neuration, especially toward the borders of the wings, by great patience and the closest examination; but most of what can be seen of the neuration adds but very little to our actual knowledge of the animal; it simply adds its testimony in the same direction as other features of the object.

The illustration of von Heyden (Pl. III, fig. 16) is faulty in several particulars, but this is not surprising when we consider the excessively obscure nature of the fossil; it represents the insect as if the under surface of both wings of one side were seen, the fore wing concealing a portion of the hind; a break in the stone is taken for the outline of the wing (just above the extremity of the costal border of the hind wing) and the markings of the two front wings are blended into one; an abdomen is represented and above it an outline of the inner border of the hind wing. The fossil has at first sight this appearance, but I think this view is erroneous, although on this point one may not speak with confidence, and it is compara-

tively unimportant. It is remarkable, however, that von Heyden, in his *description*, takes the same view of it as I have done. I have not attempted to give the shading of the darker parts of the wing, partly from its obscure nature, partly from a doubt whether they really represent the original markings of the insect; for the basal half of the under surface of the hind wings, where most of the dark mottling in Von Heyden's figure occurs, is usually devoid of any such variegation in the insects of this group; they are almost always of a uniform grayish or brownish hue. Von Heyden's figure does not show the division of the palpal joints.

Tertiaries of Rott, Rhenish Provinces of Germany. British Museum.

URBICOLÆ — ASTYCI.

PAMPHILITES Scudder.

This genus belongs to the Astyci and falls in the neighborhood of Pansydia and Carystus, if we take as an illustration of the latter group the *Hesperia Lucasii* of Fabricius. The former genus has a male with a discal dash, the latter without one. As the fossil species is represented by a single fore wing of what is probably a female, it is impossible to say into which category it would fall. The costal border (Pl. III, fig. 18) is almost exactly straight throughout; next the base, however, it is arched a little and it slopes slightly downward on the apical fifth to a rather sharply defined apex; the outer margin is gently and almost regularly convex, but with its greatest convexity a little above the middle, and at its upper end is at right angles to the tip of the costal margin; the lower angle is rounded off and the inner margin is slightly sinuous, being hollowed in the middle; the wing is slightly more than twice as long as broad. In all these respects it agrees far better with Pansydia (Pl. III, fig. 15) than with Carystus (Pl. III, fig. 13). Indeed, excepting in the greater length of the wing and the lack of any change of direction in the outer border at the tip of the lowest median nervule, the form of the wing scarcely differs from that of *Pansydia Mesogramma.*

In neuration it agrees better with Pansydia than with Carystus. Poey's figure, which for want of better material I have been forced to copy in illustration, is

not executed with sufficient care, for of the first and second superior subcostal nervules he has made but one. The principal difference between Pansydia and the fossil genus is in the fourth superior subcostal nervule; in Pansydia this terminates upon the costal border just before the apex of the wing, while in Pamphilites it terminates on the outer border just below the apex of the wing, bringing the latter into a different interspace in the two genera. From Carystus it differs, not only in having a proportionally shorter cell, but in the same point as that in which it is distinguishable from Pansydia; and further in the uppermost median nervule, which in Carystus is thrown off abruptly from the nervure just beyond its second divarication and which, by curving strongly, makes the upper median interspace of nearly equal width throughout; while in Pamphilites, the nervule parts gently from the nervure like the others, and at some distance beyond its second divarication, passing in a regular curved line to the outer border, and causing the upper median interspace to increase in breadth throughout the whole of its basal half.

In the disposition of its spots, Pamphilites (Pl. III, figs. 14, 17) agrees perhaps better with Carystus (Pl. III, fig. 19) than with Pansydia (Pl. III, fig. 15). This is especially true of the large spots in the cell and in the lower two median interspaces; although in Carystus the spots of the median interspaces are further removed from the base than in Pamphilites, while the opposite is true of the spot surmounting the submedian nervure; the submarginal spots beyond the cell of Pamphilites are wanting in Carystus, and the latter genus has but two of the three subcostal spots of Pamphilites. The spots of Pansydia are smaller and far less conspicuous than in Pamphilites, that of the cell being reduced almost to a dot; the median spots are however large, though removed farther from the base, as in Carystus; there is also a small spot in the upper median interspace, but further from the margin than in Pamphilites and unaccompanied by any spot in the interspace beyond the cell; as in Carystus, the spot surmounting the submedian nervure is further from the outer margin than in Pamphilites, but the subcostal spots accord very well with those of the fossil.

By these considerations it would appear that Pansydia is to be placed between Carystus and Pamphilites, the latter being more nearly related to Pansydia than

to Carystus, leading us to believe it more probable that we are dealing with a female, whose partner was possessed of the ornament of a discal dash of specialized scales. The species of Pansydia are smaller than those of most of the neighboring genera, but *Pamphilites abdita* is somewhat smaller even than *Pansydia mesogramma*.

PAMPHILITES ABDITA Scudder.

Pl. III, figs. 14, 17, 18.

Upon a dark, uniform, probably blackish brown ground, the fore wing of this butterfly was provided (in the female?) with three large spots, three small spots, and two dots of a vitreous appearance, besides other light streaks or powdery spots. The three large spots are probably peculiar, in their present extent, to the female; they consist (Pl. III, figs. 14, 17,) of one spot in the cell and one in each of the lower median interspaces; the cellular spot crosses the cell, is sublunato-quadrate, its exterior edge concave, extending from the origin of the third superior subcostal nervule to just beyond the second divarication of the median nervure, being directed in the upper half of its course toward the base of the second median nervule; the spot is narrower above than below, the upper half having an outward as well as upward inclination, the lower margin straight, the interior margin subsinuate, convex, reaching from midway between the base of the first and second superior subcostal nervules to just beyond the middle of the space between the base of the first and second median nervules. The spot in the lowest median interspace is nearly or quite as large as the previous, but longitudinal instead of transverse, and as broad as the interspace; excepting for a little spur above on the inner side, which runs a little way toward the base, the centre of the spot would lie just below the second divarication of the median nervure, but by means of this slight spur the spot extends baseward half way from the second to the first divarication of the median nervure; at the outer extremity the spot terminates squarely and next the lowest median nervule is two-sevenths the length of that vein. The spot in the middle median interspace is much smaller, subtriangular, filling the whole breadth of the interspace, half as long again as broad,

its inner tapering extremity situated just below the final divarication of the median nervure. The three small spots in the lower three subcostal nervules are seated one above the other, their inner margins on a line and nearly at right angles to the costal margin; they are quadrate and increase slightly in size below, the upper one being square, the lower longitudinally oblong; they are situated midway between the discoidal spot and the apex of the wing. The two dots are situated one just above the other in the middle of the upper median and subcosto-median interspaces, midway between the spot in the lower subcostal interspace and the outer border; the lower is slightly the larger, but not more than one-fourth the size of the uppermost subcostal spot. Seated upon the submedian nervure, its centre below the outer edge of the lower median spot, is a pale, powdery spot, twice as long as broad and about one-third the width of the interspace; outwardly it merges into the ground color; there are other pale spaces in the wing, looking somewhat as if due to attrition; especially in the cell on either side of the discoidal spot, at the extreme base of the lower median interspace, and along the lower border of the medio-submedian interspace. Length of wing, 15·75$^{mm.}$, length of inner border, 9·5$^{mm.}$; breadth of wing across the middle, 7·25$^{mm.}$, breadth of wing across outer margin, 9·5$^{mm.}$.

Tertiaries of Aix, Provence, France. Museum of the City of Marseilles.

COMPARATIVE AGE OF FOSSIL BUTTERFLIES.

All the well determined fossil butterflies come from one of three localities, Aix, Rott and Radoboj, all belonging to the tertiaries of Europe. Others are reported, as will be seen further on, to have been found in Prussian amber; and it is not in the least improbable that they have been or may be. These would be of about the same age as the oldest of the others, those of Aix. Of the Aix fossils, which belong to the upper Eocene, or to speak more definitely, the Ligurian, *Neorinopis sepulta*, *Lethites Reynesii*, *Thaites Ruminiana* and *Pamphilites abdita* (the first described by Boisduval, the rest by myself) come from the calcareous marls of the gypsum quarries, the only bed in which insects had been found when visited by Messrs. Murchison and Lyell in 1829. *Coliates Proserpina*, however, described here for the first time, was taken from strata beneath these, and therefore, at least until we have more precise knowledge concerning the remains of butterfly larvæ in amber, may be considered the oldest known butterfly. Count de Saporta writes me concerning this fossil, the discovery of which is due to him, as follows:—"Cette empreinte ne provient pas des platrières même, c'est à dire des galeries qui servent à l'exploitation du Gypse; mais d'une assise ou groupe de couches immédiatement inférieure. Vous verrez cette provenance indiquée pour un grand nombre de mes espèces; dans ce cas, elles ne proviennent par des ouvriers mais je les ai recueillies moi même en suivant les lits sur les points où ils affleurent au dehors."

The next in order, approaching recent times, are the lignite beds of Rott in the basin of the Rhine, which belong to the Aquitanian or the upper part of the lower Miocene. *Thanatites vetula* (described by Hayden) is the only butterfly known from this division of the Tertiaries.

The most recent beds containing fossil butterflies are the lacustrine deposits of Radoboj in Croatia, Austria. These belong to the Mayencian or lower portion of the middle Miocene, and have furnished *Eugonia atava*, *Mylothrites Pluto*,

another fragment possibly referable to Mylothrites, and *Pontia Freyeri*, all described by Heer. Two of the genera of these more recent beds contain representatives now living in the same region; but none of the older beds have yet furnished butterflies referable to modern genera.

It is rather extraordinary that the upper Miocene beds of Œningen, Bavaria, which, if we except the amber, have furnished almost more insects than all the other beds of fossil insects of the world together, and which are more recent than any of those in which butterflies have been found, have yielded scarcely any remains of Lepidoptera (one species) and none whatever of butterflies.

PROBABLE FOOD-PLANTS OF TERTIARY CATERPILLARS.

Of the five butterflies from Aix, two belong to the Oreades (*Neorinopis sepulta* and *Lethites Reynesii*) the food of whose caterpillars at the present epoch has invariably been found to be either Gramineæ or, occasionally, Cyperaceæ. Both of these groups are present in the deposits of Aix, the former being represented by ten species of Poacites, and the latter by a Cyperites;[1] and it is in the highest degree probable that these formed the sustenance of the Oreades of that epoch. A third species (*Pamphilites abdita*) belongs to the Astyci, a group whose principal food is the same family of plants, Gramineæ, although some species have been found also upon Althea, Malva and Lavatera (Malvaceæ), Trifolium, Coronilla and ?Lespedeza (Leguminosæ), Plantago (Plantaginaceæ), and Maranta (Scitamineæ). Of these families the Leguminosæ only are found at Aix, and in abundance, even including a plant doubtfully referred to Trifolium. It is, however, far more probable that Pamphilites lived upon grasses; and it is not a little strange that the Gramineæ, the probable food-plants of three of the five butterflies known from that fauna, were among the rarest of the plants; that is, their proportion to the whole phanerogamic flora was about the same as now

[1] Saporta. Revision de la flore des gypses d'Aix. Ann. Sc. Nat. [5] Bot., xv, 284.

obtains in New Guinea or New Grenada, countries the least favored in this respect.[1] The proportion of the Gramineæ and Cyperaceæ to the whole of the Phanerogamia in Europe of to-day is, probably, about the same as in the United States (more than seventeen per cent.) and much greater than in the East Indies. The limited number of known fossil butterflies does not give great weight to any general considerations based upon them, but it may at least be worth while to remark that Aix, in Eocene times, had, in the point referred to, an assemblage of plants much better comparable with the East Indian flora of the present day than with the modern European flora, the proportion of known Gramineæ, etc., to the Phanerogamia being five per cent., while the proportion of its grass-feeding butterflies to the other rhopalocerous Lepidoptera is sixty per cent. To judge simply by the catalogue of the East India Museum, the only authority upon East Indian butterflies extant, the present proportion of gramnivorous to non-gramnivorous butterflies is as 1 : 5·2, while in Europe it is as 1 : 3. Eocene Aix, then, had a European proportion of Satyrids, composed, as will be seen, of species of an Indian aspect, feeding upon plants essentially temperate, but, as in tropical countries, numerically unimportant.

The Danai, to which the fourth species from Aix (*Coliates Proserpina*) belongs, feed almost exclusively upon Leguminosæ, and these have recently been found in great abundance at Aix. Count de Saporta enumerates one species each of ? Trifolium, Caragana, Ervites, Sophora, Micropodium, Cercis and Gleditschia, two of Phaseolites and six of Cæsalpinites, belonging to the Papilionaceæ, besides nine Acacias and a Mimosa of the Mimoseæ, and four species of uncertain relations; making a series larger than he has found in any other family.[2]

Of these, two species of Phaseolites, one of Sophora, eight of Acacia and two of Leguminosites are specified as coming from the lower beds, where Coliates itself is found. But Coliates is most closely allied, as we have said, to a group of Indian forms, and the food plants of their caterpillars is almost wholly unknown.

[1] "La proportion des Graminées relativement au total des Phanérogames, qui est de 4·5 sur 100, est en rapport avec les minima relatifs de cette famille, tels qu'on les observe à la Nouvelle-Guinée et à la Nouvelle-Grenade." Saporta, loc. cit., 292.

[2] "Dans la flore des gypses d'Aix, non-seulement les Légumineuses occupent le premier rang, comme dans la plupart des flores intertropicales actuelles de l'ancien et du nouveau continent, mais elles atteignent une proportion de 13 pour 100, pour l'ensemble des Phanérogames, proportion parfaitement en rapport avec celle de 12 sur 100 qui est fréquente, selon M. de Candolle, dans certaines régions chaudes, telles que Timor, le Congo, etc." Saporta, loc. cit., 292.

A species of Delias, however, to which genus Coliates has been specially compared, is stated to feed, not upon a leguminous plant, but upon Dioscorea, one of the Yam family; and the presence in Aix of a species of a closely allied group, *Smilax rotundiloba* Sap., is announced by Count de Saporta. It is not improbable, therefore, that *Smilax rotundiloba* was the food-plant of the larva of *Coliates Proserpina*.[1]

The fifth Aix species is *Thaites Ruminiana*. It is most nearly allied to Thais of the present day, though it bears certain relations, as we have seen, to neighboring genera. Thais feeds principally at least upon Aristolochia[2] and so, too, do Ornithoptera, Archon and some genera of swallow-tails; indeed, this seems to be a favorite food-plant with insects of this character. Parnassius, however, feeds on Sedum, Telephium, Sempervivum and Corydalis, especially on the first-named, one of the Crassulaceæ; but nothing very closely allied to this is specified by Saporta from Aix; neither, also is Aristolochia, but it has been found not only in Radoboj[3] in the Mayencian, but also, according to Heer, at Hohe Rhonen in Switzerland, which belongs to the Aquitanian, and has at least one plant (*Laurus primigenia* Ung.) in common with Aix. It seems, therefore, highly probable that either *Aristolochia nervosa* Heer, *A. Aesculapi* Heer, or a distinct species of the genus will yet be discovered at Aix,[4] and may then be considered, as with little question, the food-plant of *Thaites Ruminiana*. If it be deemed hazardous to venture such an opinion, attention is called to the two following passages; the first is from the introduction to Heer's paper on the fossil insects of Aix:[5] "Dass indessen auch Weiden oder Pappeln [Populus] sich vorhanden, dürften der Bythoscopus muscarius und die Aphrophora spumifera [Homoptera] anzeigen, deren analoge lebende Arten besonders auf den Blättern und Zweigen dieser Bäume sich umhertreiben." The second is a note in the errata to the translation of Heer's work on the Climate and Vegetation of the Tertiaries[6] by Gaudin: "Le Poacites ciliatus

[1] Since this was written, Count Saporta writes me: "Le genre Smilax est un des genres tertiaires les plus frequents. J'ai aussi signalé dans le dépôt voisin de St. Zacharie (étage Tongrien inférieure [and therefore but slightly more recent]) une feuille qui m'a paru devoir se ranger parmi les Dioscorées."

[2] An old writer in Fuessly's Magazin, writing from Italy, says that Thais feeds in that country upon Quercus. Five species of Quercus are known from Aix, but the statement in Fuessly's Magazin has never, to my knowledge, been confirmed.

[3] "Nous n'avons pas encore rencontré d'Aristolochia dans les gypses d'Aix; mais l'existence du genre dans le tertiaire moyen ne saurait être mise en question, depuis que nous avons entre les mains une superbe empreinte de Radoboj (Aristolochia venusta Sap.), qui dénote une forme voisine des Aristoloches à feuilles persistantes et demi-coriaces, comme l'*A. reticulata* Nutt. de Virginie." Saporta, loc. cit., 342-3.

[4] In a recent letter from Count Saporta he remarks: "Relativement au *Thaites Ruminiana*, je n'ai pas encore decouvert à Aix de vestiges du genre Aristolochia, mais *ce genre devait y exister*."

[5] Vierteljahrsschrift naturf. Gesellsch. Zurich, I, 12, 1856.

[6] Recherches sur le Climat et la Vegetation du pays tertiaire, 4to, 1861.

Sap. n'est pas une glume de Graminée, mais plutôt une bractée ciliée de Peuplier. . . . Elle doit être probablement rapprochée d'une empreinte . . . provenant des mêmes couches et qui se rapporte également au genre Populus. Les organes voisins de ceux du Pop. Euphratica Oliv. dans la nature actuelle dénotent l'existence, à l'epoque des gypses d'Aix, d'une espèce de Peuplier dont les feuilles sont encore inconnues, comme celles de l'Alnus cryptophylla Sap., mais que M. Heer avait indiqué d'avance, en se fondant sur l'observation d'un insecte fossile, le Bythoscopus muscarius! Nouvelle preuve du secours que peuvent se prêter en paléontologie les diverses branches de l'histoire naturelle."

The single species from Rott, *Thanatites vetula*, is closely allied to the modern Thanaos, whose species are numerous and feed upon a variety of plants, belonging to the families Cruciferæ, Leguminosæ, Umbelliferæ, Cupuliferæ, Betulaceæ and Salicaceæ. Most of the genera belonging to its tribe feed upon Leguminosæ, and these are the usual food plants of the species Thanaos also; whence it is probable that Thanatites had a similar taste. Now in the very beds of Rott, in which this butterfly was found, occur species of Betula, Salix and Populus, with numerous Querci and no less than eleven genera of Leguminosæ, mostly belonging to the Papilionaceæ; they are Templetonia (1 species), Robinia (2), Colutea (1), Phaseolites (2), Sphinctolobium (1), Dalbergia (1), Hæmatoxylon (2), Gleditschia (2), Cassia (3), Ceratonia (1), and Acacia (2). It is probably among these, and perhaps with greatest probability among the species of Hæmatoxylon and Gleditschia, that the food plant of Thanatites must be sought. Should leaves be found, in which a portion is bent over as if to form a nest, they should be submitted to the scrutiny of some one familiar with the larval habitations of *Thanaos Tages;* and should traces of silken fastenings be found in connection with them, or the marks of nibbling at the edges, the plant to which they belong may be considered with strong probability as the food of *Thanatites vetula.*

The only butterfly found at Radoboj belonging to an extinct genus is *Mylothrites Pluto*, and this is a member of the same general group as Coliates, and feeds probably upon Leguminosæ; for it is not so closely allied to Delias as Coliates is, but is more nearly related to Hebomoia, one of whose species, found in the

East Indias, feeds upon Capparis.[1] One species of Phaseolites, one of Sophora and four of Cassia, namely: *C. hyberborea* Ung., *C. phaseolites* Ung., *C. lignitum* Ung., and *C. ambigua* Ung., are recorded from Radoboj, and as Cassia is a favorite food plant among the larger species of Danai at the present day, we may fairly presume one of these Cassiæ to have afforded nourishment to *Mylothrites Pluto.* Moreover, no less than thirty-one species of Leguminosæ in general, or between a ninth and a tenth of the whole known flora, are given by von Ettingshausen as occurring in Radoboj; so that in any case our Mylothrites must have found abundance of palatable food.

The food of *Pontia Freyeri* is doubtful. All the living species of the genus so far as known, feed upon Cruciferæ; within this family they do not seem to be at all particular, making use of a large number of genera, but in only a single instance are they known to attack the leaves of a genus (Reseda) belonging to an adjoining family. Cruciferæ, however, are excessively rare in the tertiaries of Europe, two species only being recorded, and this from the comparatively recent beds of Œningen. This is unquestionably due simply to the nature of the plants themselves, which scarcely could leave any trace of their existence; the almost complete absence of the herbaceous families of plants, even in the later tertiaries, is doubtless due to this fact. The plants nearest related to the Cruciferæ found near the horizon of *Pontia Freyeri* are a species of Nelumbium from Günzbourg in the Mayencian, and of Terminalia (*T. radobojensis* Ung.)—one of the Calycifloræ, from Radoboj itself. Perhaps in the absence of better evidence we may provisionally consider the latter to have been the food plant of *P. Freyeri.*

A single Radoboj species remains, *Eugonia atava.* The recent species of Eugonia feed particularly on Salix, Populus and Betula; also upon Ulmus, and occasionally on Ribes, and even on Hippophae. The first three seem however to be their proper food; and since the tertiaries of Radoboj contain fossils of all these genera, we need look no farther. There are specified: *Salix apollinis* Ung., sp.,

[1] I venture to give one more extract from a recent letter received from Count Saporta, although he writes:—"je vous écris n'ayant sous les yeux ni mes livres ni mes collections, ce qui enlevera nécessairement un peu de précision à quelques-unes de mes réponses."

"Il est bien plus difficile de justifier par des exemples tirés de la nature des plantes la présence à Radoboj d'un insecte se nourissant de Capparis. Les Capparis ont du exister, mais leur feuilles sont difficiles à distinguer à cause de l'absence de caractères différentiels; leur forme et leur nervation peu visibles doivent les faire confondre avec beaucoup d'autres. Il me semble pourtant que des Capparis ont été signalés soit à Radoboj, soit à Hoering en Tyrol, dépôt un peu plus anciens [Tongrian], mais en l'absence de mes livres je ne saurais vous l'affirmer."

Populus latior Br., *P. mutabilis* Heer., *P. Heliadum* Ung., *Betula Dryadum* Brongn. and *B. prisca* Ett. Three species of Ulmus are also recorded from the same place.

Excepting in a single case, there is then no difficulty in finding, in the very beds in which the butterflies occur, remains of plants, which in all probability served them as food during the larval stage; and even in this single instance, a plant not far removed from those upon which species of the genus now feed, occurs in the same strata.

PRESENT DISTRIBUTION OF BUTTERFLIES MOST NEARLY ALLIED TO FOSSIL SPECIES.

To discuss this question properly we must consider the butterflies of each geological horizon separately.

BUTTERFLIES OF THE LIGURIAN (Upper Eocene).

The nearest living ally of *Neorinopis sepulta* is, with little doubt, *Neorina Lowi*, which, like the other members of the genus, is found in the Indo-Malayan region. The same is strictly true of the species of Zophoessa, Debis and Lethe, with which we have been obliged to compare this fossil. Cœlites has also been used in comparison, and most of the species of this group belong to the same region, although one is described by Felder from Celebes on the confines of the Austro-Malayan region. We have also pointed out (as Butler has done, but in incorrect points) its relation to Antirrhæa, a Brazilian genus, but this is too distant to be given much weight. The closest allies of *N. sepulta* are to be found in the Indo-Malayan region.

The same is true, but not to so striking a degree, of *Lethites Reynesii*. We have compared this also to Debis, Lethe and Neorina, and especially to the two former; and all three of these genera, which are certainly its nearest allies,

are strictly confined to the Indo-Malayan region. It is, however, also related, but in a secondary degree, to Enodia, Cercyonis and Maniola, which are genera appertaining to the north temperate zone of both hemispheres.

Coliates Proserpina finds its nearest living representatives in the genus Delias, which also is strictly confined to the Indo-Malayan region. Thyca and Prioneris are closely related, the latter of which is limited to the same district and the former to the Indo-Malayan and Austro-Malayan regions.

Thaites Ruminiana is represented in recent times by the genus Thais, which is confined to the Mediterranean district, within which Aix lies. An allied genus, Archon, is also restricted to the same region. Sericinus, however, and Eurycus, with which we have been obliged to compare it in many points, are found only in the East, the former in China, the latter in Australia; while on the other hand, Parnassius, a genus it quite as much resembles, is limited to alpine and subarctic regions of the northern hemisphere.

The relations of *Pamphilites abdita* are very different. I have searched carefully for very closely allied forms among East Indian Urbicolæ; but, while it doubtless is not far removed from some of them, its more intimate relationships are certainly with insects from tropical America and especially with Pansydia and Carystus.

Three out of the five Aix butterflies, therefore, find their nearest living allies in the Indo-Malayan region, one is most closely related to forms now found in tropical America and one is at home in its own resting place.

BUTTERFLIES OF THE AQUITANIAN (Lower Miocene).

Thanatites vetula is the only butterfly yet found from this horizon, and this is closely related to Thanaos, a genus belonging to the north temperate zones of both hemispheres, but vastly more developed in the new world, which has at least four times as many species as the old, some of them extending into the subtropical regions. The genera adjacent to Thanaos are purely American, although tropical or subtropical, and therefore the Aquitanian butterfly looks toward subtropical North America for its relatives of the present day.

BUTTERFLIES OF THE MAYENCIAN (Middle Miocene).

Only a single one of these butterflies, *Mylothrites Pluto*, belongs to an extinct genus. Its nearest living representatives are to be looked for in the genera Mylothris and Hebomoia, the former of which finds its highest development in torrid Africa, while the latter is confined to the Indo-Malayan and Austro-Malayan regions.

The other two belong to modern genera, Eugonia (*E. atava*) and Pontia (*P. Freyeri*). These two genera are very similar in their distribution, spreading, like Thanaos, above referred to, over the north temperate regions of both hemispheres. Eugonia, however, is represented equally in Europe and America, while Pontia is considerably richer in species in the Old World than in the New; yet when we look into the distribution of the neighboring genera we shall find a result somewhat similar to the case of Thanaos. Taking into consideration, in the one case, the present distribution of the genera Hypanartia, Polygonia, Papilio and Hamadryas,[1] and on the other of Neophasia, Tatocheila and Leptophobia, we shall find that the largest development of these groups of genera has been in the New World rather than in the Old, but in those parts of the New World which lie on the tropical confines of the temperate zone.

Two of the more recent species of fossil butterflies are therefore at home where they are found, although the present development of the group of genera to which they belong finds its fullest expression in America; while the third species follows most of those from the lower tertiaries in seeking its allies of to-day in the tropics of the old world.

Undoubtedly the material at our disposal is, as we have already remarked, far too meagre to present any generalities of importance, so long as they are unsupported by external proof. This aid we can claim in considering the facts we have presented concerning the present distribution of the genera of butterflies most nearly allied to those once living in the neighborhood of Aix. The careful re-

[1] I use these genera in the sense indicated in my Historical Sketch of generic names. Proc. Am. Acad. Arts, Sci., X, pp. 91-293.

searches of Count Saporta upon the rich flora of this region at the same epoch, points to very nearly the same results as are here indicated. In his *Examen des flores tertiaires de Provence*,[1] when writing of the characteristics of the Aix flora, Count Saporta says (page 150) that about one-fifth of the families represented in it are now strangers to Europe; that fifty-one genera have an exotic and more or less tropical aspect, and that forty out of seventy-four, or about one-half, if not exclusively tropical, inhabit the warmer parts of southern regions, or, in small numbers, temperate extra-European countries. The result is still more striking, if species are considered, of which there are at least eighty whose individual analogy with living species is sufficiently clear to yield results of great probability. "De ces espèces," to use his own words, "12 seulement correspondent à des espèces de l'Europe moyenne, 6 à des espèces de l'Europe méridionale, 18 en tout. Les espèces correspondant à des formes de l'Amérique septentrionale ou des régions élevées de l'Amérique tropicale, sont au nombre de 10; celles qui répondent à des formes de l'Amérique tropicale s'élevent à 9 . . . ; 3 correspondent à des espèces du Cap et 2 à des espèces des îles Atlantiques et de la Barbarie; 14 representent des formes particulières aux Indes ou aux îles de l'Archipel indien et 30, enfin, correspondent à des formes australiennes. Le groupe australien est donc le plus considérable, si on les prend isolement. En les réunnissant, on voit que sur les 80 et quelques espèces, 28 à 30 seulement correspondent à des formes habitant aujourd'hui l'Europe et l'Amérique du Nord, en y comprenant même les parties méridionales de ces continents; tandis que 57 au moins, soit 60 en nombre rond, representent des formes tropicales ou subtropicales, et dans ce nombre 40 au moins, c'est-a-dire la moitié du nombre total se rapportent au Cap, aux [151] Indes orientales où à l'Australie; de sorte que le caractère dominant de cette flore est encore Austro-indien, quoique dans une proportion déjà décroissante par rapport à l'âge précédant."

This was published in 1861, and would accord entirely with what we know of the butterflies of Aix and their nearest allies. But eleven years later, after studying the great amount of material which had meanwhile accumulated, Saporta seems

[1] Heer et Gaudin, Climat du pays tertiaire, pp. 133–171.

to have reached different conclusions, for in his *Revision de la Flore des Gypses d'Aix* he states that the affinities of the eocene vegetation of Aix are with south-eastern Asia and with Africa, and lists of analogous species are given, showing that twenty-two Aix species are to be compared with similar types in Asia, and forty with those of Africa. So that African forms much surpass the Asiatic in the eocene flora of Aix. This is particularly true, he says, with reference to the region of Africa between Abyssinia and the Cape of Good Hope. "C'est là évidemment le pays qui nous offre le tableau le plus ressemblant de ce que devait être le midi de la France, et c'est aussi vers ce même pays, ne l'oublions pas, que nous avons été ramenés par l'examen des autres élémens de la flore, spécialement par la proportion relative des deux grandes classes et des familles prédominantes."[1] The African element seems to be almost altogether wanting in the eocene butterflies, while the Asiatic predominates. In a chart accompanying Count Saporta's paper, however, he represents the present limits of the *principal genera* noticed in the flora of the gypsum of Aix by means of colored lines. These lines cluster remarkably along the southern borders of Asia and extend over a large part of Africa and across the ocean to America, and particularly toward the southern United States and the Antilles. Based on the distribution of these principal genera alone, the flora of the southern border of Asia would show a closer affinity to that of eocene Aix than would that of any equivalent belt in Africa; and if we may suppose that our relics of butterflies represent the principal genera then existing, we should trace a somewhat similar chart, but for the entire absence of African types; for subtropical American types mingle with those of the Mediterranean district and especially with those of the Indo-Malayan region. Count Saporta shows in his memoir just quoted, as before, that the relations of the eocene flora of Aix to that of the present Mediterranean basin were more restricted than its relations to exotic types, but in a letter to me he writes: "Ces affinités [les affinités présumées de la flore d'Aix] sont d'une part avec la région Méditerranéen, de l'autre avec l'Afrique et les Indes orientales. Les affinités miocènes avec l'Amérique sont postérieures." These later American affinities are, however, foreshadowed among the plants and also, as we

[1] Ann. Sc. Nat., [5] Bot., xv, 322.

have seen, in the Pamphilites of eocene Aix. They appear again, and very decidedly, when we reach the miocene itself, for the affinities of the butterfly from Rott, and two of the later butterflies from Radoboj (where first we meet with truly modern types), are certainly with America in the first instance, and secondarily with the whole north temperate zone. While the last of the Radoboj butterflies shows still the remains of the earlier affinities of the Aix flora in finding its nearer existing types in Africa and southeastern Asia. The results we reach in considering the Aix butterflies are not, however, in accordance with those drawn from the insects of the same locality by Professor Heer. He writes:[1]—

"A Radoboj, . . . on rencontre une plus forte proportion de formes tropicales [than at Œningen]. . . . . .

Cette faune des insectes s'harmonise parfaitement avec le flore de Radoboj qui, ainsi que nous l'avons prouvé précédement, a un caractère plus méridional que celle d'Œningen; ce qui s'expliquerait par sa plus grande ancienneté.

Comme il résulte des recherches de M. G. de Saporta qu'Aix appartient à l'étage ligurien, on devrait s'attendre à y rencontrer encore plus de formes tropicales q'u à Radoboj. C'est tout le contraire, si bien qu'en m'appuyant sur la faune et en voyant que Aix avait 10 espèces en commun avec Radoboj et 4 avec Œningen, j'avais rapporté précédemment les terrains d'Aix à la même époque que ceux de Radoboj et je les avais rangés dans le Mayencien. Quatres genres ont disparu. . . . Tous les autres genres vivent encore dans la Provence, mais ce sont, comme à Œningen, presque tous des genres qui occupent une aire géographique très vaste. . . . On ne peut pas dire que la faune des insectes d'Aix contredise positivement l'idée que cette localité avait un climat sous-tropical, cas presque tous les genres que l'on y a observés jusqu'a présent s'étendent jusque dans la zône sous-tropicale, néanmoins cette faune ne fournit que bien peu de preuves positives, tandis que, comme M. de Saporta l'a démontré, la flore est riche en formes méridionales."

It should be remarked, however, that the insect fauna of Aix is as yet little known; that these observations of the learned Zurich Professor were founded upon

[1] Climat du pays tertiare, ed. Gaudin, p. 205.

a material exceedingly meagre, in comparison with the present vast accumulations of the museums of Marseilles, Paris and Aix; we may hope soon to become familiar with them through the careful researches of M. Oustalet; and these will show that the beds of Aix are, perhaps, even richer in fossil insects than those of Œningen.

The American affinities of the Rott butterfly are in entire harmony with what is known of the other insects of the lignites of the Rhine, where, says Professor Heer:[1]—"On retrouve également des types américains, qui appertiennent à l'Amérique tropicale et sous-tropicale."

As to the flora of Radoboj, Professor Heer writes in the work just quoted (p. 96): "Les plantes de la zône tempérée sont représentées plus fortement qu'à Sotzka," and of the latter place he says (p. 95), after speaking of types of the temperate zone: "Cependant ces espèces se trouvent fort à l'arrière-plan en comparison des formes tropicales et subtropicales, parmi lesquelles prédominent . . les formes indo-australiens; neanmoins les formes américains, loin d'y faire défaut, sont représentées par des types assez nombreux et nettement accusés." As a whole, therefore, the affinities of the tertiary butterflies seem to be precisely what we should have anticipated from a study of the vegetation of the period.

We close this portion of our subject with a tabular view of the results we have reached in considering the affinities of the tertiary butterflies with living types, in which the countries, where the living allies of the fossil forms are now found, are placed in the right-hand columns according to the degree of affinity of their inhabitants to the tertiary species against which they are placed.

[1] Loc. cit., p. 205.

	Names of Butterflies.	Degree of Affinities.			
		First degree.	Second degree.	Third degree.	Fourth degree.
Aix — Upper Eocene.	Neorinopis sepulta.	Indo-Malayan.	Austro-Malayan.		S. American.
	Lethites Reynesii.	Indo-Malayan.			North temperate Zone.
	Coliates Proserpina.	Indo-Malayan.		Austro-Malayan.	
	Thaites Ruminiana.	Mediterranean.	Chinese and Australian. Subarctic and Alpine.		
	Pamphilites abdita.	Tropical America.			Indo-Malayan.
Rott-lower miocene.	Thanatites vetula.	Subtropical North America.	North temperate Zone.		
Radoboj — middle miocene.	Eugonia atava.	Subtropical temperate America.	North temperate Zone.		
	Pontia Freyeri.	Subtropical temperate America.	North temperate Zone.		
	Mylothrites Pluto.	African.	Indo-Malayan, Austro-Malayan.		

GENERAL RESUME, WITH NOTICES OF UNDETERMINED FORMS.

Nine well authenticated fossil butterflies are now known, all from the European Tertiaries; five of these have been found in the gypsum beds of Aix in Provence, southern France, belonging to the Ligurian, a division of the upper eocene; one in the lignites of Rott in the Rhenish Provinces of Prussia, belonging to the Aquitanian, or lower miocene; and three in the marls of Radoboj in Croatia, Austria, appertaining to the Mayencian or middle miocene. Our present knowledge, then, places the apparition of butterflies towards the end of the lower tertiaries.

As a general rule the specimens thus far discovered are in a fair state of preservation, and especially are those parts preserved which enable us, with considerable confidence, to determine their exact affinities. Three of these insects belong to the highest family of butterflies, Nymphales, four to the Papilionidæ, and two only to the Urbicolæ. If it be considered probable that the lowest of these families was the oldest, we can reasonably account for the scarcity of its members in the tertiary strata by the fact that their almost universally robust and muscular frame enables them to maintain flight when they have lost all but the merest stubs of wings. They would thus seldom meet their end by falling into pools of water, or if at last they did, it would be with fragments of wings whose affinities could not be traced. This supposition would be strengthened on noticing that one of the two fossil forms classed here, *Thanatites vetula*, belongs to a group of genera which comprises the very feeblest flyers in the family; and by the further consideration that two of the three fossil Nymphalids belong to the weak-winged Oreades. Eugonia, as well as Pamphilites, were doubtless strong and bold flyers; while the genera of Papilionidæ were moderately endowed. To proceed further in the analysis of their structural relations, two of the three Nymphales belong, as we have said, to the highest group of butterflies, the Oreades, represented now by the dark brown butterflies of our meadows; the remaining one to the Præfecti, a group of gaily attired butterflies with angulated wings like our common thistle butterfly, the cosmopolite. Of the four Papilionidæ, three belong to the Danai; two of these three to the group Fugacia, represented by our common yellow brimstone butterflies; the third to the Voracia, or white butterflies of the garden, so destructive to cabbages and other cruciferous plants. The fourth Papilionid belongs to the lower subfamily Papilionides; not, however, to that group which contains our swallow-tailed butterflies, but rather to an allied tribe, represented in America only by the Parnasii of the Rocky Mountain region. The two Urbicolæ are divided between the Hesperides and Astyci, the former closely related to the dingy, sylvan hesperians of early spring, seldom seen but by the naturalist; the latter to the tawny, brisk little skippers busy around the flowers in June.

But a single family of butterflies, then, is unknown in a fossil state,—that of

Rurales; and since this comprises, in the main, insects of exceedingly delicate structure and of small size, their absence is by no means unaccountable. Yet, as we shall see further on, there are intimations of the presence of some of their caterpillars in amber, and an obscure and doubtful reference to a fossil Polyommatus from the beds of Aix.

If we enquire where the allies of these nine fossil butterflies are now living, we must seek for those of four of them in the East Indies; for those of three of them in America, and especially in that part lying on the confines of the tropical and north temperate zones; for those of one of them in the north temperate zone of both Europe-Asia and America; and for those of one in the Mediterranean district; for those of two only, therefore, out of the nine, or less than one-fourth, in the region where the fossils were discovered. Analyzing this point still further, we notice that three out of the four species whose living allies are to be sought in the East Indies come from the older deposits of Aix, and that only one of the two remaining Aix species shows special affinities to American types; we thus find here, as among other insects and among the plants, a growing likeness to American types as we pass upward through the European tertiaries.

The study of the floras of the European tertiaries has proceeded so far that in most cases we are able to find, in the very beds where the butterflies occur, plants which we may reasonably judge to have formed the food of these insects in their earlier stages. In but a single instance is the family of plants, upon which it was necessary, or almost necessary, to suppose the caterpillar fed, entirely absent from tertiary strata; and since this family is the Cruciferæ, which in its very nature could scarcely have left a recognizable trace of its presence, the exception has no force.

After presenting these facts, for convenience sake, in a tabular form, we will pass on to the enumeration of those fossils which have been referred to butterflies, but whose exact position is still unsettled.

TABULAR VIEW OF FOSSIL BUTTERFLIES.

Names of Species (and families).	First referred to genus.	First described by	When described.	Found in	Geological Horizon.	Preserved in Museum of	Nearest living allies found in	Probable food of caterpillars.	Parts of wings preserved.
(*Nymphales*). Neorinopis sepulta Butl.	Cyllo.	Boisduval.	1840	Aix.	Ligurian, (upp. Eocene).	Count Saporta, Aix.	E. Indies.	Gramineæ.	Perfect wings of one side.
Lethites Reynesii Scudd.	Satyrites.	Scudder.	1872	Aix.	Ligurian, (upp. Eocene).	Marseilles.	E. Indies.	Gramineæ.	Both fore-wings nearly perfect, superimposed.
Eugonia atava Scudd.	Sphinx.	Charpentier.	1843	Radoboj.	Mayencian, (mid.Miocene).	?	North temperate Zone.	Salix, Populus or Betula.	Upper half of one fore-wing.
(*Papilionidæ*). Mylothrites Pluto Scudd.	Vanessa.	Heer.	1849	Radoboj.	Mayencian, (mid.Miocene).	Hof mineralien-Kabinet, Vienna.	E. Indies.	Leguminosæ (Capparis?).	Both fore-wings nearly perfect.
Coliates Proserpina Scudd.	——	Scudder.	1875	Aix.	Ligurian, (upp. Eocene).	Count Saporta, Aix.	E. Indies.	Smilax.	Two fore-wings superimposed.
Pontia Freyeri Scudd.	Pierites.	Heer.	1849	Radoboj.	Mayencian, (mid.Miocene).	Hof mineralien-Kabinet, Vienna.	Temperate America.	Cruciferæ? Terminalia??	One fore-wing nearly perfect, but neuration obscure.
Thaites Ruminiana Heer.	Thaites.	Scudder.	1875	Aix.	Ligurian, (upp. Eocene).	Professor Heer, Zurich.	Mediterranean district.	Aristolochia.	All the wings; those of one side nearly perfect.
(*Urbicolæ*). Thanatites vetula Scudd.	Vanessa.	Heyden.	1859	Rott.	Aquitanian, (low. Miocene).	British Museum.	Subtropical N. America.	Leguminosæ (Hæmatoxylon Gleditschia).	All the wings, but superimposed and very obscure.
Pamphilites abdita Scudd.	——	Scudder.	1875	Aix.	Ligurian, (upp. Eocene).	Marseilles.	Tropical America.	Gramineæ.	One fore-wing perfect.

In the earliest accounts that we have found, including all those in the last century, the generic term Papilio was used for all Lepidoptera, and therefore we cannot be certain whether butterflies or moths are meant. Hueber's plates, even, are so inferior that they afford no additional aid; but those of Sendel possibly represent, as we have noticed in the Bibliography at the commencement of this memoir, the early stages of butterflies preserved in amber. The only other direct references to butterflies preserved in amber are the following: Gravenhorst,[1] in his enumeration of amber insects, gives under the Lepidoptera forty specimens referable to Tineæ and Tortrices, and besides these "mehre Raupen, sämmtlich, wie es scheint, Schildraupen, denen des Papilio W. album ähnlich." The probable nature of the ancient forest yielding amber renders it unlikely that any butterflies in their perfect state would be found in it. As a rule, butterflies are eminently fond of the light. This has already been remarked by Menge:[2]—"Das fehlen grõszerer schmetterlinge im bernstein deutet auf einen finstern undurchdringlichen urwald, den die kinder des lichts gemieden haben." Yet as some Theclas do feed upon coniferous trees, it is not impossible that the onisciform larvæ, referred to by Gravenhorst, may belong to this group. As far as we can discover, no further reference is made to them, excepting by Giebel and Bronn in some of their lists and enumerations of fossil insects. The writings of Berendt, Menge and others, all bear testimony to the great rarity of Lepidoptera in amber, and most of those which have been discovered belong to the lowest two families, above referred to.

Dr. Hagen informs me that he has himself seen specimens of large butterflies in amber, but that these proved to be falsifications, recent European insects like *Pieris rapæ*, etc., having been enclosed between slabs of amber, which were then fastened together and the edges roughened, all in so clever a manner that one would not suspect them to be spurious. These specimens were manufactured many years ago, and it is not impossible that it is to one of them that Hope refers in 1836, as found in the collection of Mr. Strong, though why he should quote Berendt as authority I cannot discover.

Heer, in the introduction to the lepidopterous portion of his "Insektenfauna

[1] Arbeit. Schlesisch. Gesellsch. Vaterl. Kultur, 1834, 92-3.

[2] Programm Petrischule Danzig, 1855-56, 4°, p. 30.

der Tertiärgebilde von Œningen," says (p. 175): "Karg erwähnt zwar eines sehr schönen Œninger-Schmetterlings, der nach Zürich gekommen sein soll. Allein hier findet sich dieser nicht und die Angabe verliert noch mehr an Werth, wenn wir berücksichtigen, dass Karg das Thier nicht selbst gesehen hat." Karg's memoir in the "Denkschriften der Schwäbischen Gesellschaft der Aertze und Naturforscher," T. I, I have been unable to examine.

Boisduval, in his final report upon *Neorinopis sepulta*, remarks that Count Saporta had written him that many years previously he had sent to the Paris Museum a "Polyommate fossile" from Aix. Count G. de Saporta, in reply to my inquiries concerning this specimen, says that his father can give me no further information concerning this specimen; nor could M. Oustalet and myself, in our search through the fossil insects of the Jardin des Plantes, discover any such relic.

In a recent number of "Nature" (No. 266), Mr. E. J. A'Court Smith writes of the discovery at Gurnet Bay in the Isle of Wight, of an insect bed in which were found, among other things, "a variety of flies, butterflies, and one or two grasshoppers;" no further information has yet been published concerning these relics, and my inquiries upon the subject have not, as yet, elicited any definite response.

NOTICE OF INSECTS WHICH HAVE BEEN ERRONEOUSLY REFERRED IN RECENT TIMES TO BUTTERFLIES.

1. *Cyllonium Boisduvalianum* WESTW., and *C. Hewitsonianum* WESTW.

These two insects were figured by Westwood in the Quarterly Journal of the Geological Society of London for November, 1854, the former (reproduced in our fig. 2) on Pl. XVII, fig. 17; the latter (reproduced in our fig. 3) on Pl. XVIII, fig. 27. Of the former he makes the following remarks:[1] "Pl. XVII, fig. 17 represents a number of fragments of delicate tegument, covered with minute punc-

[1] Loc. cit., 387.

tures and traversed by straight and somewhat radiating veins, which appear like portions of the hind wing of some species of Butterfly, entirely denuded of scales." The name is given to it in a note to the explanation of the plates, p. 395. Concerning the second he says:[1] "Pl. XVIII, figs. 27 and 30, appear to be portions of the hind wings of some species of Butterfly; still they have very much of a vegetable aspect. The surface is covered with minute punctures, which may be the cells for the insertion of the quills of the coloured scales, which are all removed, supposing the specimens to be Lepidopterous." The name we have quoted is given only to fig. 27, in a foot note on p. 396.

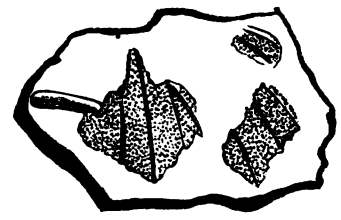


Fig. 2.
Cyllonium Boisduvalianum Westw.

I have not been able to find, even with Mr. Brodie's help, the first specimen referred to; but an examination of the original of the latter (see fig. 3) proved that, while it is unquestionably an insect, it cannot be referred to the Lepidoptera; the punctures referred to are both too large and much too irregularly disposed to have been the points of insertion of the scales; they are probably the marks of the insertion of hairs, such as are not uncommonly seen irregularly scattered over the wings of insects belonging to the other suborders. As the figure of the first species closely resembles in this particular the one I have seen, I am forced to the conclusion that neither of these wings are lepidopterous. Plainly, the only reason why a new generic name was appended to these forms was that their remains were too fragmentary to afford the slightest guess as to what modern genus they might be referred. The fossils came from the English Purbecks.

Fig. 3.
Cyllonium Hewitsonianum Westw.

2. *Palæontina oolitica* BUTL.

The first notice I find of this remarkable and very interesting fossil is that published in various literary and scientific London journals reporting remarks

[1] Loc. cit. 390.

given at a meeting of the Entomological Society of London, and which afterward appeared as follows in their Proceedings:[1]

"Mr. Butler exhibited a remarkably perfect impression of the wing of a fossil butterfly in the Stonesfield slate. It appeared to be most nearly allied to the now existing South American genus Caligo."

A full description of this insect soon appeared in the author's "Lepidoptera Exotica," accompanied by a plate; both were afterward republished in the "Geological Magazine." In fig. 4 we reproduce fig. 1 of his plates, representing the neuration of Palæontina; and in fig. 5, fig. 2 of his plates, subsequently copied by "The Graphic." A description of the genus and species is first given, which it is unnecessary to reproduce here; afterward, the following remarks:

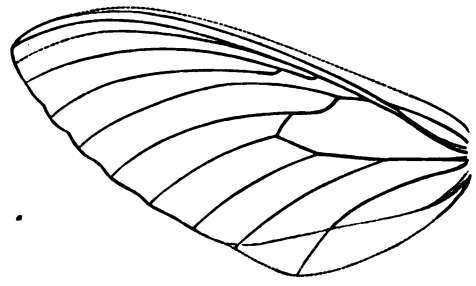


Fig. 4.

Palæontina oolitica Butl.
The neuration, after Butler's first sketch.

"[126] Though a British insect, this species belongs to a group so completely tropical that I do not hesitate to describe and figure it in the present work;

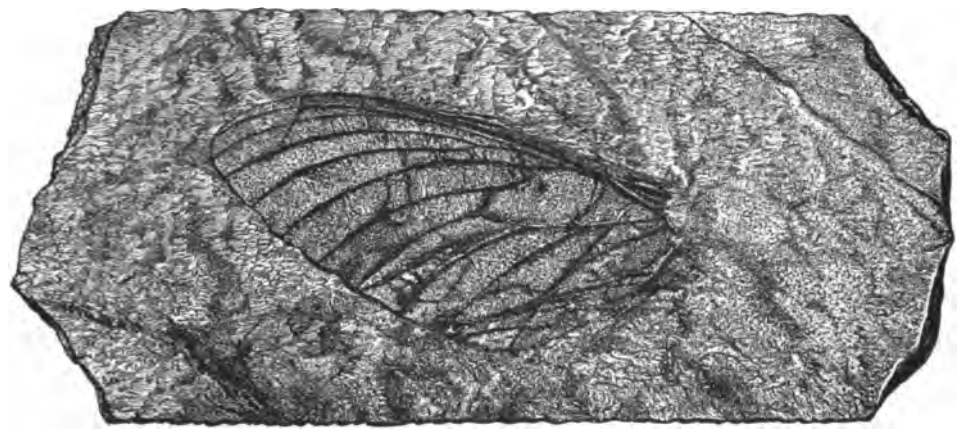


Fig. 5.

Palæontina oolitica Butl. Facsimile of Butler's first sketch.

its nearest allies are the genera Caligo, Dasyophthalma and Brassolis, all three essentially tropical American genera.

"*P. oolitica* is especially interesting, as being the oldest fossil butterfly yet dis-

[1] 1872. xxxi.

covered; the most ancient previously known to science having been found in the Cretaceous series (white sandstone of Aix-la-Chapelle[1]), whilst the bulk of the known species are from the Lower Miocene beds of Croatia; it is also interesting as belonging to the highest family of butterflies, and to a subfamily intermediate in [127] character between two others, namely, the Satyrinæ and Nymphalinæ, whilst the more recently discovered fossils are referable, with one exception, to the two latter groups. The nervures appear to have been impregnated with iron, which will partly account for their well-defined condition."

Happening to be in London not long after the publication of the description and illustration of this insect, I took pains to make a very careful examination both of the original specimen, which Mr. Charlesworth kindly allowed me to study at my leisure, and of its reverse, which is preserved in the School of Mines, Jermyn street. I mentioned to Mr. Butler and to others, my conviction that the insect was to be considered homopterous rather than lepidopterous, and on my return to America, exhibited before the Natural History Society of Boston, drawings which I had made from the originals; my comments at that time were published very briefly, as I was reserving the proof of my statements for the present paper. Mr. Butler, however, was induced by this publication[2] to examine the reverse at the Jermyn street Museum, and although he had been supplied by me with a rough tracing of the drawing I had taken of it, he failed to be convinced of any mistake, and published a paper in defence of his own view in the Geological Magazine for October, 1874. In this paper he gives new drawings of the insect, quotes portions of letters in which I had expressed my opinions upon the nature of the fossil, gives the remarks referred to from the "Proceedings of the Boston Society of Natural History," and makes, among others, the following comments.

"Seeing that Mr. Scudder had made his views public, I felt that it was time for me to take similar steps on my side. I therefore availed myself of an early opportunity of again visiting Jermyn street, where, through the courtesy of the officers, I was enabled to make a sketch of the impression in the Museum. I

[1] Perhaps Mr. Butler is not altogether to blame in confounding Aix in Provence with Aix-la-Chapelle; at any rate the mistake had been made previously by the translator of Heer's paper in the Quarterly Journal of the Geological Society of London, VI, 72; the error is corrected by Mr. Butler at the end of his volume.

[2] He seems not to have seen the earlier publication of Mr. Brodie.

found it impossible to make a tracing of it, and therefore drew the whole by measurement. This sketch is now produced on Pl. XIX, fig. 4 [see fig. 6]; and any body can judge for himself whether or not it is more perfect than that which I previously figured (see Geol. Mag., 1873, Vol. X, p. 2, Pl. I, fig. 2 [see fig. 5]).”

Fig. 6.
Palæontina oolitica Butl.
Facsimile of Butler's second sketch.

“In order to show the extent to which the Jermyn street example is deficient, I have restored it (fig. 5 [our fig. 7]), filling in the blanks from Mr. Charlesworth's specimens. By comparing the latter with the wing of *Dasyophthalma* (fig. 1), and *Cicada* (fig. 2), one may come to a pretty accurate conclusion as to the group of insects to which it ought to be referred.”[1]

The neuration of Lepidoptera as a group is the simplest in the whole order of insects, if we except that of the elytra of Coleoptera; this is due, doubtless, to the fact that their wings are heavily scaled, concealing the nervures; just as in Coleoptera, the thickness and opacity of the fore wings often completely masks the neuration.

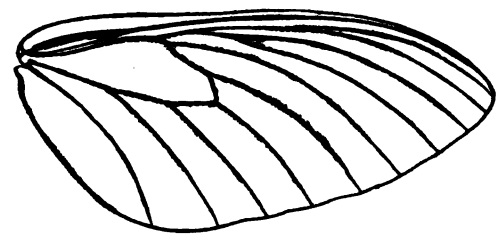


Fig. 7.
Palæontina oolitica Butl.
The neuration, after Butler's second sketch.

The normal number of veins in the wings of insects is six, disposed to a certain extent in pairs; the middle pair usually ramify to a greater extent than the others, and support most of the membrane of the wing. In butterflies the foremost vein is always absent and very commonly the hindmost, so that there are but five (often but four) principal veins, usually designated, though not very appropriately: costal, subcostal, median, submedian and (when present) internal, reciting them in their order from in front backward. The costal, submedian and internal nervures are invariably simple and terminate at the margin, or are occasionally lost in the membrane of the wing. The subcostal and median nervures, on the other hand, are as invariably forked,

[1] Geol. Mag. [2] I, 448.

and with their branches support nearly the entire wing; the subcostal nervure curves downward and the median upward so as to meet, or nearly to meet, not far from the middle of the wing, and to enclose between them a large space called the discoidal cell; the branches of the median nervure are all thrown off from its lower edge before union with the subcostal; the principal branches of the subcostal nervure are, on their side, thrown off from its upper edge; but, as the nervure curves downward at the extremity of the cell, another set is thrown off (at least in the fore wings) from the lower edge; and it is these veins, rather than the subcostal nervure proper, which unite with the median to close the cell.[1] None of the median, nor any of the inferior subcostal nervules are ever branched; but at the apex of the wing, where the play of neuration is usually the greatest, the last superior subcostal nervule is occasionally forked in the front wing. This is the only forked branchlet in either of the wings.

The last figure of *P. oolitica* given by Mr. Butler agrees in all its essential features with his first illustration. They both represent a front wing with four principal nervures,—costal, subcostal, median and submedian; the costal nervure is swollen at the base and extends, unbranched, to the tip of the wing; the median nervure is three-branched, the three forks simple, equidistant, emitted from the apical half of the vein, which at its extremity is united by a cross vein to a branch of the subcostal, closing the cell; the submedian nervure is simple and divides the space between the median vein and the margin of the wing. So far all is in accordance with the lepidopterous type; but when we examine the subcostal vein, which occupies nearly half the wing, the resemblance ceases altogether. This vein is represented as bearing no superior branches, but as sending out from its *inferior* surface three distinct veinlets, the first and second of which again emit a tributary from their inferior surfaces. This is a structural anomaly which finds no counterpart whatsoever in any family of butterflies. So that should we accept Mr. Butler's own sketch of the fossil as correct, it would be impossible to consider the wing that of a butterfly.

[1] These veins have been given a distinct name (discoidal) by the English Entomologists, as if they had an independent origin, and had nothing to do with the subcostal nervure; but by the use of this name, we wholly lose sight of the simple plan of neuration belonging to the wings of these insects. I have therefore preferred to speak of them as the inferior subcostal nervules, in contradistinction to the superior branches of the same vein.

In his description of the insect Mr. Butler compares the neuration to that of Caligo, and says its nearest allies are Caligo, Dasyophthalma and Brassolis. In his latter paper he figures the wing of a Dasyophthalma by way of comparison. In the genera named all the branches of the subcostal nervure are simple, and are thrown off from the superior surface, excepting the single set which is emitted from beneath, and which marks (as in all butterflies) the limit of the discoidal cell; this corresponds fairly with the first set of inferior veins emitted by the subcostal vein in the fossil; for the other sets, however, no counterpart will be found in the living types.

It was probably Mr. Butler's want of familiarity with fossils that led him to overlook several features which can be seen in these originals. Having first traced the outline of the wing and the general course of the veins directly from the specimens, I subsequently filled in by measurement all the other parts which I could follow, studying each vein, or supposed vein, with the utmost care, from one end to the other of its course. The result of that study is presented in fig. 8, which differs essentially in its details from the illustrations given by Butler, and looks, as he himself confesses, "exceedingly anti-lepidopterous."

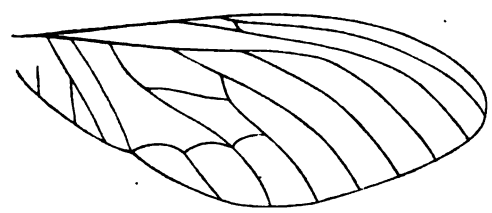


Fig. 8.

Palæontina oolitica Butl.
Corrected sketch of the neuration.

In the first place, the wing is much narrower than depicted by him; and at the extremity of a vein (the submedian vein of Butler's sketch) there is a slight but decided bending inward of the membrane, as very frequently occurs at the line of demarcation between the middle and inner area of the wing in all or nearly all the lower suborders of insects, but never, so far as I am aware, in Lepidoptera. What he has given as a simple costal vein is neither swollen at the base nor simple, but has two inferior branches near the middle of the wing, united near their origin by an oblique cross vein. Branching of the costal vein is unknown in Lepidoptera; but if it should be claimed that this might be the subcostal, just as much difficulty will be encountered with the structure and relationship of the veinlets below, which must then be considered as belonging

to the median vein; in no Lepidoptera can any such irregularity be shown, nor so disproportionate a magnitude of the area covered by the median nervure and its branches; a branched internal vein and cross-veins, which probably united all the longitudinal nervures at no great distance from the outer border (but which can only be certainly predicated for the lower three median interspaces), place this insect wholly beyond the pale of the Lepidoptera. It is but fair to say that Mr. Butler, having examined the original after he had in his possession a tracing of fig. 8, denies the existence of the cross-veins; there is one point, however, which an unprejudiced examination of the fossil cannot fail to show; that Butler's "fourth branch" of the subcostal[1] arises not from his third branch, but from his upper discoidal vein; if he can reconcile either this or the points already referred to (on the supposition that his sketch is otherwise an accurate one) with the neuration of any group of butterflies, the writer will be the first to acknowledge it.

As our only purpose in this place is to deny the lepidopterous character of Palæontina, it is unnecessary to say anything in defence of the view we have expressed of its homopterous affinities; the superior position of the cell, the position and character of the lower cross veins (which we believe really traversed the entire wing), with their origin at the indentation of the lower border, suggest such a relationship, although there are not a few points in which it differs somewhat strikingly from living types.

The discovery of a fossil in the cabinet of the Rev. Mr. Brodie, which was found in England at the same or nearly the same horizon, as *P. oolitica*, and which seems to be a pupa case of one of the Cicadida of rather unusual size, renders my suggestion more worthy of credence.

At the conclusion of his latter paper Mr. Butler draws attention to the fact that Messrs. Westwood and Bates had expressed their agreement with his views. It should, however, be borne in mind, that, so far as appears from any facts which have been published, these gentlemen, whose well considered views upon the subject would unquestionably be of great weight, expressed this assent only upon a brief evening examination of a very obscure fossil in a poorly lighted hall, and before any one had questioned its lepidopterous character.

[1] In this case he counts from the tip of the wing, in reverse order.

EXPLANATION OF THE PLATES.

[My best thanks are due to my courteous friend Mr. Auguste Sallé, for his kind agency in securing an artist for the engraving of these plates. Owing, however, to the distance at which the work was done, a few errors have unavoidably occurred, which, to prevent misapprehension, are mentioned below.]

Plate I.

Fig. 1. *Eugonia atava.* Copied from Heer, Insekt. Tert. Œning., ii, pl. xiv, fig. 8 (†).

" 2. *Lethites Reynesii.* Drawn by S. H. Scudder (†).

" 3. *Eugonia atava.* Copied from Charpentier, Nov. Act. Leop.-Carol., xx, pl. xxii, fig. 4 (†).

" 4. *Eugonia j.-album.* Neuration of fore wing; drawn by S. H. Scudder (†). The second superior subcostal nervule is carried too far toward the tip of the wing.

" 5. *Lethites Reynesii.* Fore wing; drawn by S. H. Scudder (‡).

" 6. *Eugonia j.-album.* Markings of the upper surface of the fore wing; drawn by S. H. Scudder (†).

" 7. *Eugonia atava.* Neuration of tip of fore wing (‡); copied from Heer, Insekt. Tert. Œning., ii, pl. xiv, fig. 3ª.

" 8. *Neorinopis sepulta.* Markings of the upper surface of the two wings, restored; drawn by S. H. Scudder (‡). The drawing represents the general effect of the fore wing as darker than the hind wing, and in so far is inaccurate.

" 9. *The same.* Neuration of the two wings, separated; drawn by S. H. Scudder (‡).

" 10. *The same.* Neuration of the two wings, as seen in the fossil; drawn by S. H. Scudder (‡). The engraver has unfortunately made the lines of the hind wing the heavier, as if it lay uppermost; they should have been the lighter.

" 11. *The same.* Right hind leg; drawn by S. H. Scudder (‡).

" 12. *The same.* Left hind leg; drawn by S. H. Scudder (‡).

" 13. *The same.* Drawn by S. H. Scudder (†). The spot of the medio-submedian interspace of the fore wings has not been well rendered by the engraver.

" 14. *The same.* Copied from Lefebvre, Ann. Soc. Ent. France [2], ix, pl. iii, II, fig. A (†).

" 15. *The same.* Copied from the same, fig. C (†).

" 16. *The same.* Copied from the same, fig. B (†).

" 17. *The same.* Copied from Boisduval, Ann. Soc. Ent. Fr., ix, pl. 8 (†).

Plate II.

Fig. 1. *Zophoessa Sura.* Neuration of the wings; drawn by G. Willis (†).

" 2. *Mylothrites Pluto.* Copied from Heer, Insekt. Tert. Œning., ii, pl. xiv, fig. 4 (†).

" 3. *Zophoessa Sura.* Markings of the upper surface of the wings; drawn by G. Willis (†).

" 4. *Delias Pasithoe.* Neuration of the wings; drawn by G. Willis (†).

" 5. *Coliates Proserpina.* Neuration and markings of fore wings; drawn by S. H. Scudder (‡). The tip of the costal nervure has been extended too far toward the apex of the wing.

" 6. *Lethe Dyrta.* Neuration of the wings; drawn by G. Willis (†).

" 7. *Mylothrites Pluto.* Neuration of the wings; after a drawing obtained through Mr. Brunner de Wattenwyl (†). The second superior subcostal nervule on the left wing should join the nervure midway between the bases of the first and third nervules.

Fig. 8. *Neorina Lowi.* Neuration of the wings; drawn by G. Willis (½).
" 9. *Lethe Dyrta.* Markings of the lower surface of the fore wing; drawn by G. Willis (½).
" 10. *Debis Sinorix.* Neuration of the wings; drawn by G. Willis (½).
" 11. *Zophoessa Sura.* Markings of the lower surface of the fore wing; drawn by G. Willis (½).
" 12. *Pontia Protodice.* Neuration and markings of the upper surface of fore wing; drawn by S. H. Scudder (½.)
" 13. *Neorina Lowi.* Markings of the upper surface of the wings; drawn by G. Willis (½). This was drawn for the pattern of markings only; the neuration is faulty.
" 14. *Debis Sinorix.* Markings of the upper surface of the wings; drawn by G. Willis (½).
" 15. *Mylothrites?* sp. Copied from Heer, Insekt. Tert. Œning., ii, pl. xiv, fig. 5 (½).
" 16. *Pontia Freyeri.* Copied from Heer, Insekt. Tert. Œning., ii, pl. xiv, fig. 6 (½).
" 17. *Mylothrites Pluto.* After a drawing from the original, furnished by Mr. Brunner de Wattenwyl (½).
" 18. *Pontia Freyeri.* Drawn from the original under the direction of Mr. Brunner de Wattenwyl (½).

Plate III.

Fig. 1. *Thaites Ruminiana.* Neuration of the wings, restored; drawn by S. H. Scudder (⅔).
" 2. *Thais Rumina.* Neuration of the wings; drawn by S. H. Scudder (½).
" 3. *Thaites Ruminiana.* Markings of the upper surface of the wings, restored; drawn by S. H. Scudder (⅔).
" 4. *Thais Rumina.* Markings of the upper surface of the wings; drawn by S. H. Scudder (½).
" 5. *Parnassius Smintheus.* Markings of the upper surface and neuration of the wings; drawn by S. H. Scudder (½).
" 6. *Thaites Ruminiana.* One of the wing-covers (patagia); drawn by S. H. Scudder (1½).
" 7. *The same.* Portion of the palpi; from a camera sketch by S. H. Scudder (1½).
" 8. *The same.* Antenna; drawn by S. H. Scudder (3).
" 9. *The same.* From a camera sketch by S. H. Scudder (⅔).
" 10. *The same.* Drawn under the camera from the reverse of fig. 9, by S. H. Scudder (⅔).
" 11. *Thanaos Juvenalis.* Drawn in the position of fig. 12 by J. H. Emerton (½); fig. 11 a, the palpus, denuded (3).
" 12. *Thanatites vetula.* Drawn in outline by an artist in the employ of H. Woodward, Esq., of the British Museum, and filled in by S. H. Scudder (⅔). Incorrectly named *Thanatites Juvenalis* on the plate.
" 13. *Carystus Lucasii.* Neuration of fore wing. Drawn by G. Willis (½).
" 14. *Pamphilites abdita.* Markings of the upper surface of the fore wing; drawn by S. H. Scudder (⅔).
" 15. *Pansydia Mesogramma.* Neuration and disposition of spots on the fore wing; copied from Poey, Cent. Lep. Cuba, 2ª Dec. (½).
" 16. *Thanatites vetula.* Copied from Heyden, Palæontogr., viii, pl. i, fig. 10 (⅔). Incorrectly named *Thanatites Juvenalis* on the plate.
" 17. *Pamphilites abdita.* Markings of the upper surface of fore wing; drawn by S. H. Scudder (½).
" 18. *The same.* Neuration and disposition of the spots on the fore wing; drawn by S. H. Scudder (3).
" 19. *Carystus Lucasii.* Markings of the upper surface of fore wing; drawn by G. Willis (½).

LIST OF WOOD CUTS.

Fig. 1 (p. 50). *Mylothrites Pluto.* Outlines to show the disparity in size of the two insects referred to this species by Heer; drawn by S. H. Scudder; engraved by S. S. Kilburn.

" 2 (p. 89). *Cyllonium Boisduvalianum.* Copied by photography from Westwood, Quart. Journ. Geol. Soc. Lond., x, pl. xvii, fig. 17; engraved by H. Marsh.

" 3 (p. 89). *Cyllonium Hewitsonianum.* Copied by photography from the same, pl. xviii, p. 27; engraved by H. Marsh.

" 4 (p. 90). *Palæontina oolitica.* Copied by photography from Butler, Lep. Exot., pl. xlviii, fig. 1; engraved by H. Marsh.

" 5 (p. 90). *The same.* Copied by photography from the same, fig. 2; engraved by H. Marsh.

" 6 (p. 92). *The same.* Copied by photography from Butler, Geol. Mag., [2] i, pl. xix, fig. 4; engraved by H. Marsh.

" 7 (p. 92). *The same.* Copied by photography from the same, fig. 5; engraved by H. Marsh.

" 8 (p. 94). *The same.* Drawn by S. H. Scudder; engraved by S. S. Kilburn.

ERRATA.

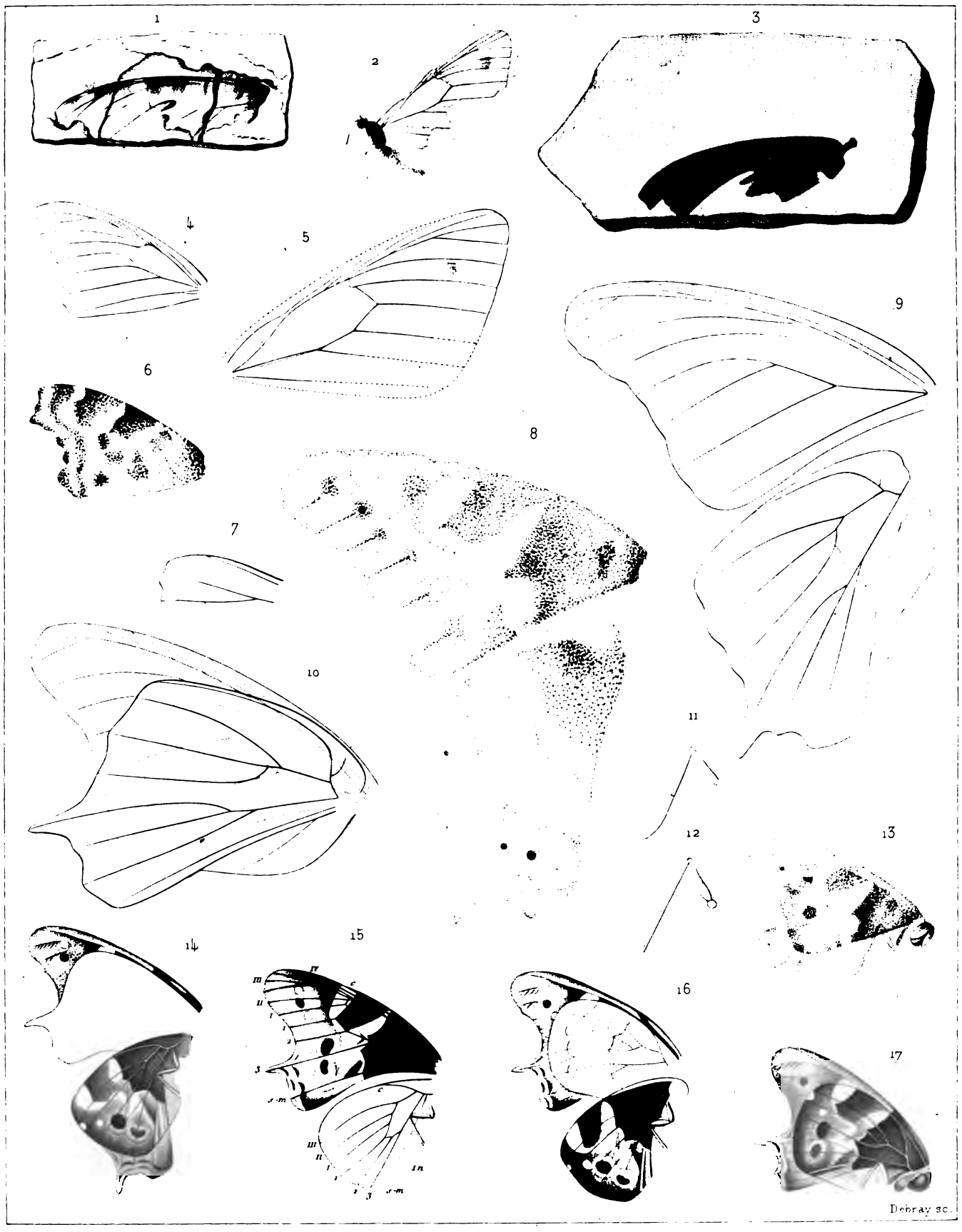
Page 19, line 4; *for* voicé, *read* voici.

" 29. The first three lines form a part of the quotation from Butler, and should have been but single-leaded.

" 51, note; *for* Dareal, *read* Danai.

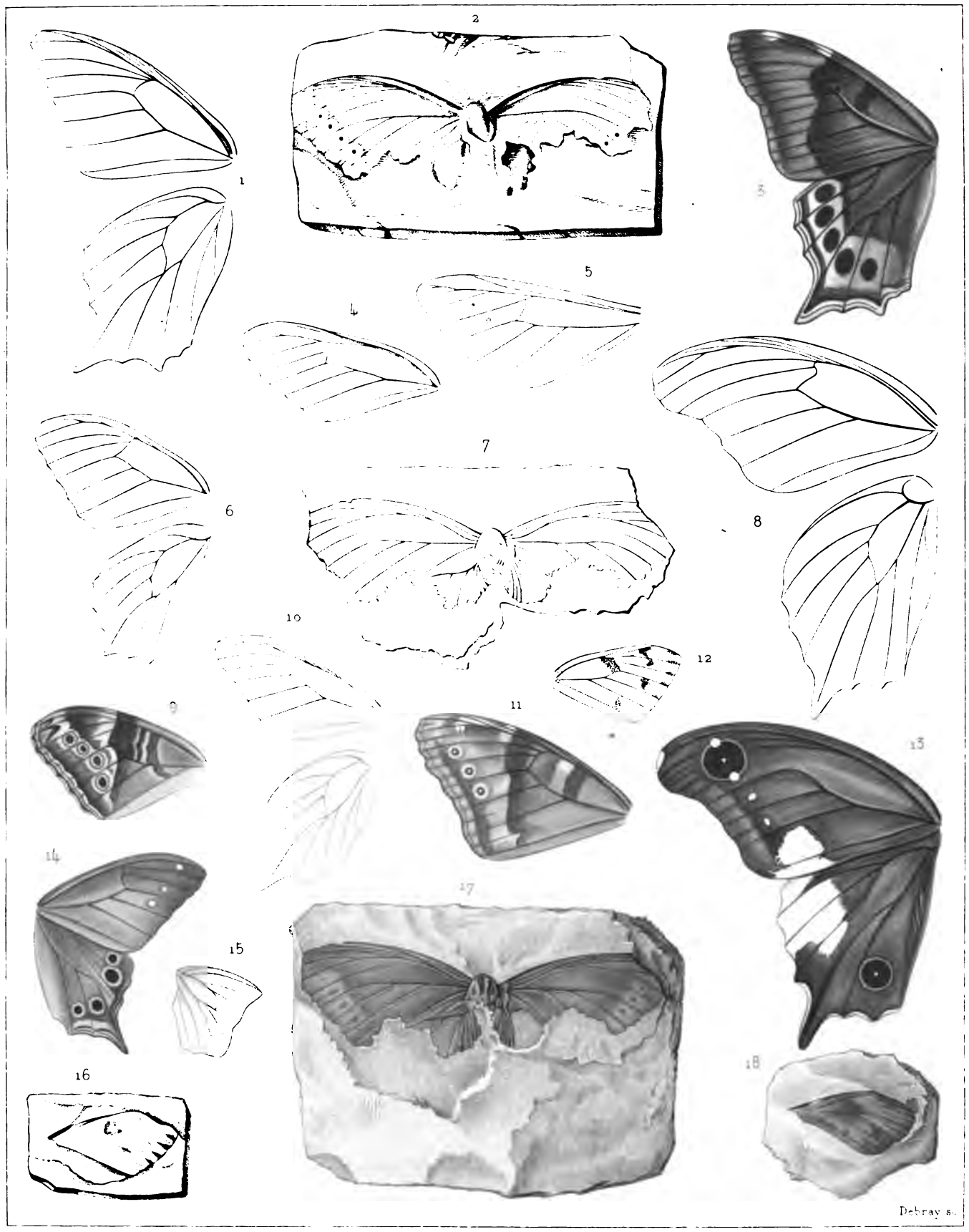
" 58, line 9; *for* before the cell, *read* before the tip of the cell.

" 62, line 13; *for* fig. 2, *read* fig. 11.



1, 3, 7 Eugonia atava. 4, 6 Eugonia J-album. 2, 5 Lethites Reynesii. 8 17 Neorinopis sepulta.

Imp. Ch. Chardon aîné, Paris.



1, 3, 11 Zophoessa Sura. 2, 7, 17 Mylothrites Pluto. 4, Delias Pasithoe. 5. Coliates Proserpina 6, 9 Lethe Dyrta. 8, 13 Neorina Lowii. 10, 14 Debis Sinorix. 12 Pontia Protodice. 15 Mylothrites ? 16, 18 Pontia Freyeri.

Imp. Ch. Chardon aîné, Paris